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OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

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MEMORANDUM

SUBJECT: ATRAZINE: OCCUPATIONAL AND RESIDENTIAL EXPOSURE ASSESSMENT AND RECOMMENDATIONS FOR THE REREGISTRATION ELIGIBILITY DECISION DOCUMENT

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This document has been updated from the preliminary version published on November 15, 2000 (G. Bangs, D269565). Revisions and corrections are based on comments and corrections received from HED reviewers and the registrant (Syngenta) during the 30-day error correction phase. This document, and the conclusions contained herein, are substantially unchanged from the previous version.

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100-645, 100-731, 19713-290, 2491-327, 35306-4, 557-1763, 557-1965, 557-1983, FL80002400, IA97000100, ID83000900, KS98000300, OK830028, OK830029, OK830030, OK83003000, OK85000500, OK85000600, OK91000100, OK91000300, OK92000500, OK92000600, OK92000700, OK92000800, OK93000400, OK93000500, OR79007700, OR80010000, OR88001400, OR95001000, TX92000100, TX92000200, TX92000500, TX92000600, VT80000800, WA79007800, WA80008300, WA80008301, WA80008302, WA-880019, and WA95001000.

Submitted Studies:

Registrant-submitted exposure-related studies:

MRIDs: 430165-06; 439344-15; 439344-16; 439344-17; 435986-09; 439344-18; 440086-01; 441521-06; 441521-08; 441521-09; 441521-11; 443154-03; 443154-04; 445976-04; 445976-05; 445976-06; 448836-01; 449580-01; 449588-01

Agricultural Reentry Task Force (ARTF) Studies:
ARF010; ARF009; 426891; 428300; ARF023; 424281; 430627

Outdoor Residential Exposure Task Force (ORETF) Studies:
449722-01

PHED: Yes, Version 1.1 (August, 1998)

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OCCUPATIONAL AND RESIDENTIAL EXPOSURE AND RISK ASSESSMENTS

EXECUTIVE SUMMARY

Purpose

This document presents the occupational and residential exposure and risk assessment for the herbicide atrazine. Atrazine, 2-chloro-4-ethylamino-6-isopropylamino-S-triazine, is a triazine herbicide registered to control a wide variety of annual broadleaf weeds and some grassy weeds. Registered use sites include food/feed crops, non-food crops, outdoor residential, and forestry. In agriculture, the greatest use occurs in corn, followed by sorghum, and sugarcane. It is used as an herbicide on several other crops, and is widely used on sod and selected turf grasses, including home lawns and golf courses. Atrazine is available for home use in several forms, including a "weed and feed" granular formulation and hose-end spray.

Hazard Identification

The Report of the Hazard Identification Assessment Review Committee (HIARC) for atrazine, revised December 21, 2000, indicates that there are toxicological endpoints of concern for atrazine. Based on analysis of study data submitted, residential dermal and incidental oral exposures are not anticipated to exceed 30 days duration, for handler and postapplication exposures. Occupational handler and postapplication worker exposures to atrazine are anticipated to be both short- and intermediate-term, although most agricultural handlers will probably be exposed less than 30 days per year. "Short-term" residential and occupational exposures were defined, for the purpose of this risk assessment, as 1-30 days duration, intermediate-term as up to several months, and long-term as several months to one year.

A short-term oral endpoint was selected for incidental oral exposure in children, using a NOAEL of 10 mg/kg/day based on a statistically significant decrease in maternal body weight gains at 70 mg/kg/day (LOAEL) in a developmental study in rats.

For short-term dermal exposure, a dermal endpoint was selected, based on decreased body weight gains in a 21-day dermal toxicity study in the rabbit. Rabbit dermal permeability to pesticides may be an order of magnitude greater than human skin, and studies of both human and rat dermal penetration were available. Therefore, the NOAEL of 100 mg/kg/day from the rabbit toxicity study was multiplied by the rat:human relative penetration factor of 3.6 to obtain a NOAEL of 360 mg/kg/day for risk assessment. For intermediate-term or long-term dermal exposure, an oral endpoint was selected based on attenuation of the pre-ovulatory LH surge (indicative of hypothalamic disruption) in a subchronic study in Sprague-Dawley rats with a NOAEL of 1.8 mg/kg/day. The committee recommended a dermal absorption factor of 6% (rounded up from 5.6%) based on a human dermal penetration study in which 10 human volunteers were exposed to a single topical dose of atrazine.

Due to a lack of inhalation studies, the HIARC selected an endpoint from oral studies for inhalation risk assessments. For short-term inhalation exposures, the endpoint selected was based on an oral developmental study in rats which showed decreased body weight, as well as other effects, at a NOAEL of 10 mg/kg/day. For intermediate and long-term inhalation exposure, the same oral study was chosen as for dermal exposure of this duration, with a NOAEL of 1.8 mg/kg/day. An absorption factor of 100% is applied for inhalation exposures.

Given the common endpoint of decreased body weight gain, the short term oral, dermal and inhalation exposures can be combined in an aggregate assessment. Because the dermal and inhalation endpoints for intermediate-term exposure are based on the same study, the doses for dermal and inhalation routes, when adjusted for absorption, may be added together to aggregate. The target margin of exposure (MOE) of 100 or more for occupational exposure scenarios was selected based upon 10x for intraspecies and 10x for interspecies variation. The target MOE of 1000 or more was selected for residential exposure based on retention of the 10X FQPA Safety Factor.

The carcinogenic potential of atrazine was discussed by the Science Advisory Panel (SAP) on June 27, 28 and 29th, 2000. The Cancer Assessment Review Committee (CARC) considered the comments of the SAP in meetings on November 1 and December 13, 2000. The CARC classified atrazine as "Not Likely to Be Carcinogenic to Humans. Therefore, no cancer exposure assessment has been performed in this assessment.

Occupational and residential incident data for atrazine have been extensively reviewed by the Agency and other epidemiological experts. For occupational cases, atrazine appears to have a less than average hazard of moderate or major effects. For cases involving children under six years of age, atrazine exposure was more likely to result in minor or moderate symptoms, but this was based on relatively few cases. Non-occupational cases showed greater evidence of hazard with higher percentages of cases with moderate and major effects as well as requirements for health care and hospitalization. Studies of apparent elevations in incidence of cancer in working populations have found no statistically significant risks.

On the list of the top 200 chemicals for which National Pesticide Telephone Network received calls from 1984-1991 inclusively, atrazine was ranked 33rd with 117 incidents in humans reported and 28 incidents in animals (mostly pets). From the review of the Incident Data System, it appears that a majority of cases involved skin illnesses such as dermal irritation and pain, rashes, and welts and eye illnesses such as eye damage, blurred vision, conjunctivitis, irritation, and pain. Poison Control Center data tend to support the Incident Data System results, dermal and ocular effects were the most common effects reported due to occupational exposure.

Occupational Handler Exposure and Risk Estimates

The Agency has determined that there are potential exposures to mixers, loaders, applicators, and other handlers during usual use-patterns associated with atrazine. Fifteen major exposure scenarios were identified for atrazine, including mixing, loading, and applying using aerial, ground spray, granular,

fertilizer admixture, and lawn application methods. The major handler scenarios involved multiple crops and application rates, resulting in 139 different exposure estimates. The largest agricultural use of atrazine, and the largest potentially exposed occupational population, involves the mixing, loading and application of atrazine to row crops. Most of the occupational exposure studies submitted by the registrant have measured exposure of these workers. Several studies monitored potential dermal and inhalation exposure to full time mixer/loaders and applicators in the corn belt. These studies used either passive dosimeters, urine biomonitoring, or both. All of the passive dosimetry studies reported residues in terms of the parent compound, atrazine, only. The biomonitoring studies measured urinary chlorotriazines and back-calculated atrazine dose.

The Agency also reviewed an agricultural handler study that included both passive dosimetry and biomonitoring of urinary metabolites of atrazine, and found the unit exposures were within one order of magnitude of the values in the Pesticide Handler Exposure Database (PHED) v. 1.1. The PHED is used by the Agency as a surrogate chemical database for handler exposure values. The passive dosimetry study was re-submitted by the registrant, in combination with the Agency's PHED values for ground applicators using enclosed systems. This was included as part of the risk estimates and compared to PHED-based estimates for agricultural handlers using closed systems, with reasonable agreement. Another study using biomonitoring to determine worker exposure included over 100 replicates, but did not meet adequate quality control criteria to allow the results to be related the quantity of atrazine handled. Instead, the range of daily dose per "typical" agricultural handler of atrazine in various formulations, using a variety of protective gear and application systems, confirms the findings of the other biomonitoring study and supports the the overall agricultural handler risk assessment based on passive dosimetry.

Occupational and Residential Exposure Task Force (ORETF) data (where available) were used to estimate exposure and risks for Lawn Care Operators (LCOs) and some residnetial applicators.

Risk Estimates for Handler Scenarios

Short-term Exposure Duration

For short-term exposure estimates based on PHED data, chemical specific exposure studies, and/or ORETF data, with appropriate personal protective equipment (PPE) or engineering controls, all short-term aggregate (dermal and inhalation) handler exposure scenarios had MOEs greater than 100 and thus do not exceed HED's level of concern. There were no exposure data for liquid atrazine/liquid fertilizer treatment, so risk estimates for this scenario could not be calculated.

Based solely on PHED data, and after consideration of personal protective equipment (PPE) or engineering controls, all short-term aggregate (dermal and inhalation) exposure scenarios had MOEs greater than 100. Engineering control methods were only required to mitigate exposure for one scenario.

The chemical specific passive dosimetry and biomonitoring studies support the PHED assessment. In these studies, the handlers monitored largely used closed mixing and loading systems and enclosed cab sprayers (that is, they incorporate PPE and engineering controls). From the combined passive dosimetry/biomontoring handler study, the 90th percentile biomonitoring values provided short-term estimated MOEs of 100-400 for mixing, loading, and applying liquid formulation by groundboom. The passive dosimetry 90th percentile exposure data for the same handler scenarios produced MOEs ranging from 130 to 390. Using the 90th percentile of the biomonitoring-only study data, normalized to body weight, short-term daily MOEs greater than 100 (range 740-2600) were estimated for all mixers, loaders, applicators, and mixer/loader/applicators applying ground spray to corn.

Using the ORETF study data, baseline short-term MOEs for LCOs spraying lawns or applying granular formulations were all greater than 100.

Intermediate-term Exposure Duration

For intermediate-term exposure estimates based on PHED data, chemical specific exposure studies, or a combination thereof, with appropriate personal protective equipment (PPE) or engineering controls, most (approximately 80%) intermediate-term aggregate (dermal and inhalation) handler exposure scenarios had MOEs greater than 100 and thus do not exceed HED's level of concern. There were no exposure data for liquid/liquid fertilizer treatment, so risk estimates for this scenario could not be calculated.

Using PHED data incorporating PPE and/or engineering controls, 108 of the 139 (78%) of the handler exposure scenarios had intermediate-term aggregate (dermal and inhalation) MOEs greater than 100. There were no data for liquid/liquid fertilizer treatment and the right-of-way and hand sprays had no known engineering controls.

Using the corn applicator study/PHED combined data, with engineering controls, 51 of 62 applicable handler scenarios (82%) had MOEs greater than 100. Using the passive dosimetry study data alone, which reflected the use of engineering controls, the geometric means of the estimated doses result in handler MOEs of 210-520. Biomonitoring study data for handlers using mostly engineering controls provided estimated MOES of 69-1600 using the geometric mean for each task. Some MOEs were less than 100 when based on the 90th percentile study doses.

Using the ORETF study data, all baseline clothing intermediate-term LCO handler scenarios had MOEs greater than 100.

Intermediate-term exposures that exceed HED's level of concern are generally associated with mixing and loading of the largest quantities (liquid or dry flowable/WDG) of atrazine or with LCO applications. Examples include the higher application rates and acerages for use on chemical fallow lands, grasslands, corn, sorghum, and in fertilizer admixture. With engineering controls, all applicator risk estimates have MOEs above 100.

Postapplication Worker Exposure and Risk Estimates

Most of the atrazine used in agriculture is applied to corn and sorghum early in the season, either before weeds emerge (pre-emergence) or when the crops are quite small (generally less than 12 inches high). This fact, and the degree of mechanization in cultivating these crops, minimizes the postapplication contact of workers to atrazine.

Three chemical-specific studies, one of dislodgeable foliar residue on corn, and two of transferable turf residues (TTR), were submitted to the Agency. All three were reviewed and found to acceptable for use in the atrazine risk assessment. Wherever possible, transfer coefficients (Tc) used in dermal exposure calculations were based upon data submitted by the Agricultural Reentry Task Force (ARTF).

Using the highest average daily foliar residues from each study at day 0-1 and day 7 after treatment, all postapplication short- and intermediate-term dermal risk estimates were below the HED's level of concern (range 100-220,000). The lowest MOEs, for trimming/harvesting Christmas trees (120) and harvesting sod (100), used a combination of day 0-1 atrazine-specific residue study data and standard assumptions for activities, which produced a screening-level exposure estimate. These latter assessments should also be adequate for use as surrogates for other postapplication exposure scenarios for which more data are needed, such as working with other tree crops and in sugarcane fields

Residential Handler Exposure and Risk Estimates

Five residential handler exposure scenarios were evaluated. The method of risk assessment for adult residential handlers was essentially the same as that for occupational workers with similar application methods. The *Standard Operating Procedures (SOPs) for Residential Exposure Assessments* (*revised 1999-2000*) and the Outdoor Residential Exposure Task Force (ORETF) study data were compared, and the better data used to estimate exposure.
ORETF data were only available for two of the five exposure scenarios.

All dermal and inhalation short-term residential handler MOEs were greater than 1000, and aggregate (dermal + inhalation) MOEs ranged from 2200 to 110,000).

Residential Postapplication Exposure and Risk Estimates

Dermal postapplication exposure estimates were conducted using the average daily postapplication residues from each of the chemical specific turf transferable residue (TTR) studies (granular and dry-flowable formulations). Dermal transfer coefficients from the revised Residential SOPs were used. The SOPs use a high contact activity based on the use of Jazzercise to represent the exposures of an actively playing child. These assumptions are expected to better represent residential exposure exposure and are still considered to be high-end, screening level assumptions.

A total of 8 dermal postapplication exposure scenarios were evaluated. Two of these scenarios , both involving application of a liquid formulation, had short-term dermal MOEs less than 1000, for high-contact activities on turf for the child (MOE = 390) and adult (MOE=660). Residues had dissipated sufficiently by the 2nd day after treatment to raise MOEs for children to 2600 and adults to 4500. For adults golfing and mowing on treated turf, all short-term dermal MOEs exceeded 1000. Assuming all of the adult dermal exposures (golfing, mowing, high-contact activities) would happen in one day over 8 hours, the aggregate dermal MOE ranges from 600 to 14,000, depending on the formulation applied to the turf. This high-end aggregate risk estimate is driven by the single adult and child 'high-contact activity' scenario of concern.

It is possible for an adult resident to apply atrazine by one of several methods to their lawn, then, later that same day, take part in activities on the lawn, such as sports. Therefore, the aggregated doses from applying atrazine by hose-end spray and then working or playing on the treated lawn the same day yields an MOE of 510. This should be considered a high-end, screening level exposure estimate.

Lacking dislodgeable residue data (because children's hands may be wet and sticky and TTR data was obtained with dry wipe methods), the Residential SOPs were used to estimate incidental oral exposure for toddlers (young children) licking their fingers after touching treated turf. Therefore, the risk estimate for finger licking is based on the application rate of 2 lbs ai/acre, and formulation is not a factor. Because dislodgeable foliar residue were provided for corn, but not for turf, the corn DFR, normalized for a 2 lb ai/acre application rate, was applied to the turf (or treated object) mouthing scenario. The finger-licking MOE alone was 330, while mouthing grass and soil ingestion MOEs (1800 and 100,000, respectively) were both greater than 1000. The aggregated (finger licking + mouthing grass + soil ingestion) incidental ingestion MOE was 280. Incidental ingestion of atrazine granules was not aggregated, as it is considered episodic in nature, but all scenarios had MOEs of concern (single dose; 0.42%-1.5% ai; MOE 25-180).

It is considered reasonably likely that dermal and oral incidental exposures may occur in the same day for children playing on atrazine-treated lawn. However, both the short-term dermal and short-term hand-to-mouth exposures have MOEs less than 1000. Aggregating the route-specific MOEs results in an MOE of 160, which further exceeds the level of concern.

A single label for atrazine 4L (EPA Reg. No. 829-268) permits professional application to "corn in the home garden." As this was the only such label use found, the potential postapplication risk to residents was not quantitatively assessed; but as the potential risk estimated for postapplication workers was low (MOE > 1000), the residential risks are also considered low.

Uncertainties in Risk Assessment and Data Gaps

While uncertainty cannot be completely removed from any pesticide risk assessment, there is a substantial amount of actual field monitoring data for occupational handlers of atrazine in the largest area of use, field crops. The studies support the handler exposure and risk estimates stated here, given that

most of the estimates are for typical-to-high application rates and acreages per day. Less data were available for most of the other crops and the fertilizer admixture scenarios. The postapplication risk estimates for field crops and turf are based on acceptable guideline field residue study data and are therefore of high confidence. Most of the remaining occupational postapplication risk estimates were extrapolated from those residue studies using the best available crop-specific transfer coefficients, but are considered more uncertain because of the translation of residue data from one crop to another.

Residential handler exposure and risk estimates were conducted using two sets of surrogate chemical data: the ORETF study data and the Residential SOPs. These data sets have not yet been fully compared, and therefore there are significant uncertainties in the risk estimates. Dermal postapplication exposures to atrazine were based on the highest residues from the chemical-specific TTR study data and are of fairly high confidence. Oral ingestion scenarios are based on standard assumptions and formulae (Residential SOPs) which are designed to be screening level. Granular ingestion is considered episodic in nature.

Recommendations/Data Requirements

Appropriate protective clothing to protect the skin and eyes of handlers and field workers is recommended. For workers who may have extensive exposure to atrazine, skin protection should be required. Based on the estimated risks, all occupational handlers of atrazine should wear chemical resistant gloves, and enclosed systems should be used when handling large quantities.

The treatment, mixing, loading, and application of dry and liquid fertilizers, both commercially (including cooperatives) and on-farm, had risk estimates of concern. Additional data or information about the methods, quantities, and usual practices used would help to refine this risk assessment. More data and information are also needed regarding application and postapplication activities on tree farms and in conifer forests.

Risk estimates for residential granular application by push-spreader and postapplication exposure on granular treated turf do not exceed the level of concern. Application of granular formulation by hand or with hand-held devices should be prohibited by label. Current labeling should be strengthened to prevent accidental ingestion by children, and the watering-in requirement is important. The only residential postapplication exposures which exceeded the level of concern were estimated using the NC site spray application study residues. The irrigated granular applications had the lowest residues and produced lower risk estimates. A single label for atrazine 4L (EPA Reg. No. 829-268) permits professional application to "corn in the home garden," which, when compared to occupational workers' exposure estimates, should not be of concern.

This deterministic postapplication residential risk assessment, which used both of the atrazine TTR studies' average residue levels, resulted in some MOEs which exceed the Agency's level of concern. A probabilistic approach to the use of the various residue study data would help to refine the risk estimates.

OCCUPATIONAL AND RESIDENTIAL EXPOSURE ASSESSMENT FOR ATRAZINE

BACKGROUND

Purpose

In this document, which is for use in the Agency's development of the Atrazine Reregistration Eligibility Decision Document (RED), the results of the review of the potential human health effects of occupational and residential exposure to atrazine are presented.

Criteria for Conducting Exposure Assessments

An occupational and/or residential exposure assessment is required for an active ingredient if (1) certain toxicological criteria are triggered and (2) there is potential exposure to handlers (mixers, loaders, applicators, etc.) during use or to persons entering treated sites after application is complete. For atrazine, both criteria are met.

Summary of Toxicity Concerns Relating to Occupational and Residential Exposures

The Report of the Hazard Identification Assessment Review Committee (HIARC) for atrazine, revised December 21, 2000, indicates that there are toxicological endpoints of concern for atrazine. Based on analysis of study data submitted, residential dermal and incidental oral exposures are not anticipated to exceed 30 days duration, for handler and postapplication exposures. Occupational handler and postapplication worker exposures to atrazine are anticipated to be both short- and intermediate-term, although most agricultural handlers will probably be exposed less than 30 days per year. “Short-term” residential and occupational exposures were defined, for the purpose of this risk assessment, as 1-30 days duration, intermediate-term as up to several months, and long-term as several months to one year.

Acute Toxicology Categories

Table 1 in the Appendix presents the acute toxicity categories as outlined in the Report of the Hazard Identification Assessment Review Committee, December 21, 2000. Atrazine is moderately toxic (toxicity category III) for acute oral and dermal exposures. It is less toxic (toxicity category IV) for exposure by inhalation route, and primary skin and eye irritation, and dermal sensitization. An acceptable acute neurotoxicity study was not received.

Other Endpoints of Concern

The Report of the Hazard Identification Assessment Review Committee (HIARC) for Atrazine, dated December 21, 2000, identified toxicological endpoints of concern for atrazine. The doses and

endpoints used in assessing the occupational and residential risks for atrazine are presented in Table 2. A short-term (1-30 days) oral NOAEL of 10 mg/kg/day was selected, based on a statistically significant decrease in body weight gains in pregnant female rats at 70 mg/kg/day (LOAEL). This endpoint is appropriate to evaluate incidental oral exposures (e.g., hand-to-mouth) in children. Using maternal effects seen during the first five days of dosing is also appropriate for comparison to short-term exposures in females of reproductive age, as in biomonitoring studies. The intermediate-term (one month to several months) endpoint is based on estrous cycle alterations and LH surge attenuation at a NOAEL of 1.8 mg/kg/day. The effects were seen after a minimum of one month in the six month study chosen and after one month of continuous dosing in a second study at 2.5 mg/kg/day. These endocrine effects are biomarkers of atrazine's potential to disturb hypothalamic-pituitary function, which may lead to various health consequences.

The committee recommended a dermal absorption factor of 6% (rounded up from 5.6%). This factor is based on a human dermal penetration study (MRID 44152114) in which 10 human volunteers were exposed to a single topical dose of atrazine.

For short-term dermal exposures, an endpoint was selected based on a 21-day rabbit dermal toxicity study. The observed effects were reduced food consumption, mean body weight, body weight gain, increased spleen weights at the LOAEL of 1000 mg/kg/day in mid-dose females at days 7 and 14. Because both rat and human dermal absorption studies were available, a rat:human dermal penetration factor of 3.6 was calculated. The study NOAEL of 100 mg/kg/day was multiplied by the rat:human dermal penetration factor of 3.6, resulting in an endpoint for short-term dermal exposures of 360 mg/kg/day.

For intermediate-term or long-term dermal exposure, an endpoint of 1.8 mg/kg/day was selected based on estrous cycle alterations and LH surge attenuation (indicative of disruption of hypothalamic-pituitary function) at 3.65 mg/kg/day (LOAEL) in a six month study in Sprague-Dawley rats. The endpoint of concern was seen after 6 months of exposure and is appropriate for this exposure period of concern. The 21-day dermal study was not selected since estrous cycle evaluations and LH measurements (both of which have been shown to be very sensitive endpoints following atrazine exposure) were not performed in this study. Since an oral NOAEL was selected, the 6% dermal absorption factor should be used in route-to-route extrapolation.

With the exception of an acute inhalation study, no inhalation studies are available for evaluation. Therefore the HIARC selected oral studies for inhalation risk assessments. For short-term inhalation exposures, the oral NOAEL of 10 mg/kg/day, described above, is applicable. An inhalation absorption factor of 100 percent is applied. For intermediate and long-term inhalation exposure, the oral endpoint of 1.8 mg/kg/day was chosen.

A urinary biomonitoring study of atrazine handlers study (MRID 435986-04) was submitted to support the use of chlorotriazine residues to extrapolate an internal dose. The average total chlorotriazine residues excreted in the urine in the first, second, and third days after a single oral dose represented approximately 12%, 2% and 0.5%, respectively, of the total amount taken orally. The

least variation between the six male subjects (chlorotriazine excreted dose = 11.6% of parent atrazine with SD of 3.35%) was seen in the first 24 hours after dosing.

Margin of Exposure (MOE)

The margin of exposure (MOE) is the ratio of the endpoint dose to the actual dose, adjusted for absorption as necessary. The MOE provides a margin between the known effect level seen in studies (usually animal) and the human exposure. The MOE is an attempt to account for variation in susceptibility between species and individuals. The HIARC selected a MOE of 100 as protective for occupational exposures. The Food Quality Protection Act (FQPA) Committee met on October 23, 2000, and again on November 8, 2000 to evaluate the toxicological and exposure database for atrazine. The committee determined that the 10-fold FQPA Safety Factor should be retained for atrazine. Therefore, a target MOE of 1000 is appropriate for all exposure routes for children and females of reproductive age in residential (non-occupational) settings.

Aggregate Risk Estimates

Because the short-term oral, dermal and inhalation endpoints chosen are based on the common effect of decreased body weight gain, the dose for each route may be aggregated. For intermediate and long-term aggregate exposures, the three routes can be combined because the dermal and inhalation exposures are corrected to oral equivalent doses and are based on the same endpoint as the reference dose (RfD).

Cumulative Risk Estimates

Atrazine belongs to a class of chemicals which are called triazines and include several other herbicides, namely simazine and propazine. Cumulative risk from all triazines has not yet been evaluated, because the methodology for estimating such risks is still being completed.

Carcinogenicity

The carcinogenic potential of atrazine was discussed by the Science Advisory Panel (SAP) on June 27, 28 and 29th, 2000. The Cancer Assessment Review Committee (CARC) considered the comments of the SAP in meetings on November 1 and December 13, 2000. The CARC classified atrazine as "Not Likely to Be Carcinogenic to Humans. Therefore, no cancer exposure assessment has been performed in this assessment.

Incident Data

The following is a summary of an incident review by Jerry Blondell and Monica Spann of HED (2000). A number of studies and reports, by the Agency, pesticide industry, and various researchers, have investigated health incidents associated with atrazine and its metabolites. Some of the more recent reports,

which attempt to explain the relative risk represented by the reported rates of incidences, are summarized here and documented in the references.

Based on occupational incident data, atrazine appears to have fewer reported cases with moderate or major effects than other major pesticides. Non-occupational cases showed greater frequency of cases with moderate and major effects as well as cases requiring treatment, but this was based on a relatively small number of cases and there was evidence that these effects may have been coincidental with rather than due to the exposure.

For incidents involving children under six years of age, atrazine exposure was most likely to result in minor or moderate symptoms. But it should be noted this was based on relatively few cases, seven children with minor symptoms and two children with moderate symptoms. Dermal and ocular effects accounted for the majority of symptoms associated with exposure to atrazine, though a number of cases also reported gastrointestinal, neurological, and respiratory effects.

California Data - 1982 through 1996

Detailed descriptions of one case submitted to the California Pesticide Illness Surveillance Program (1982-1996) were reviewed. In the case, a worker used the product to contribute to production of a commodity. Specific symptoms were not mentioned.

National Pesticide Telecommunications Network

On the list of the top 200 chemicals for which the National Pesticide Telephone Network received calls from 1984-1991 inclusively, atrazine was ranked 33rd with 117 incidents in humans reported and 28 incidents in animals (mostly pets).

Literature Review

No major literature citations were found concerning poisoning incidents due to atrazine. There are a number of cancer epidemiology studies of atrazine or triazine herbicides as a group, several of which have been previously reviewed by HED.

HED concluded that none of the epidemiologic studies reviewed add significant new information concerning adverse health effects of atrazine. A non-significant elevation in non-Hodgkin's lymphoma (NHL) continues to be observed at the Louisiana plant among workers exposed to triazines, including atrazine. By itself, this study does not support a conclusion of increased cancer from exposure to triazines. However, this study could be considered supportive, but only supportive and not definitive, if evidence of an association between non-Hodgkin's lymphoma and triazine exposure was available from other studies. Follow-up by the National Cancer Institute in four states looked specifically to determine whether earlier associations in individuals studies could be attributed to atrazine when adjustment was made for exposures to other pesticides. They concluded that "detailed analyses suggested that there was little or no increase in the risk of NHL attributable to the agricultural use of atrazine" (Zahm et al. 1993). In January, 2000, Dr. Ruth H. Allen of the Agency reviewed five epidemiological studies with findings related to atrazine, including

cancer incidence. The most statistically significant (odds ratio 3.00) findings related ovarian cancer and atrazine exposure among workers in a corn growing region of Italy. The findings would need to be evaluated in a larger study to confirm or refute them. Cancer is a relatively rare disease and the Italian observations are biologically of interest, despite the low number of cases. Other types of cancer in the U.S. were not found to have statistically significant correlation to atrazine exposure.

SUMMARY OF USE PATTERN AND FORMULATIONS

Occupational-Use and Resident-Use Products

Atrazine, 2-chloro-4-ethylamino-6-isopropylamino-S-triazine, is a triazine herbicide registered to control a wide variety of annual broadleaf weeds and some grassy weeds. Use sites include food/feed crops, non-food crops, outdoor residential, and forestry.

Atrazine formulations are restricted to use by licensed pest control operators (PCO) or lawn care operators (LCO), except for some home lawn products with low concentrations of active ingredient which may be applied by private residents. The greatest use in agriculture occurs in corn, followed by sorghum, and sugarcane. Atrazine is also used for weed control in macadamia nuts and guava orchards, in sod production, and on conifer forests and Christmas tree farms. It is also used as an herbicide on non-cropped industrial lands and on fallow lands. Atrazine is also widely used on several non-agricultural sites, primarily on selected (mostly southern) turf grasses for fairways, lawns, or other residential turf grass. It is also registered for use as an aid in the establishment or renovation of existing conservation reserve program (CRP) acres. Atrazine may be combined with fluid fertilizers, or impregnated on dry bulk fertilizers. Resident-use products are widely available, primarily as "weed and feed" type granular formulations, but also as a liquid for spray application.

Type of pesticide/target pests

Atrazine is a selective triazine herbicide registered to control a wide variety of broadleaf weeds and some grassy weeds such as quackgrass, barnyard grass, cheat, giant foxtail, green foxtail, crabgrass, wild oats, witchgrass, yellow foxtail, cocklebur, downy brome, Japanese brome, Kentucky bluegrass, siregrass, Flora's paintbrush, spanish needles, marestale, groundcherry, jimsonweed, kochia, lambsquarters, annual morning glory, mustards, nightshade, pigweed, purslane, ragweed, sicklepod, velvetleaf, wild buckwheat.

Formulation types and percent active ingredient

Atrazine is formulated for occupational use as a liquid (10 to 80% active ingredient), wettable powder (39 to 80% active ingredient), dry flowable (16 to 90% active ingredient) and a granular product (0.42 to 1.5% active ingredient). In several formulations, atrazine is combined with other active ingredients, usually herbicides, and it is also formulated with fertilizer.

Physical Characteristics

Atrazine has a molecular weight of 215.7, a low vapor pressure (3.0×10^{-7} mm Hg), is stable to photolysis and hydrolysis, and dissipates relatively slowly on foliage.

Registered use sites

Occupational-use sites

Atrazine is registered for occupational-use on corn, sorghum, sugarcane, macadamia nuts, guava, fallow lands, conservation reserve program grasslands, roadsides, rights-of-way, conifer forests, Christmas tree farms, and selected turf grasses for lawns, fairways, and sod production.

Non-occupational-use sites

Atrazine is registered for use on lawns and turf grown in parks, playgrounds, and other residential areas. It is also used on sod farms and golf courses. Residents may apply atrazine formulations to lawns using granular or spray products.

Application Rates and Timing and Frequency of Application

Atrazine is typically applied as a preplant, preemergence, or early post emergence herbicide in agriculture. For most usages, including turf, atrazine is applied once or twice per season. With a few exceptions, outlined below, the maximum use rate for atrazine is 2.0 lbs ai/acre per application. The maximum label rates were used to estimate handler exposure.

- **Corn and Sorghum**: Label specifies a maximum use rate of up to 2 lb ai/acre per application with a maximum seasonal application of 2.5 lb ai/acre per year. Maximum of 2 applications per year.

- **Conifer Forests or Farms**: Application rates range from 2 to 4 lbs ai/acre for most weeds with a maximum of 4 lb ai/acre for quackgrass. Maximum of 1 application per year. Treatments are applied over the conifers.

- **Chemical Fallow:** Wheat-sorghum-fallow has a maximum application rate of 3 lb ai/acre, wheat-corn-fallow has a maximum application rate of 1.5 lb ai/acre and wheat-fallow-wheat has a maximum application rate of 0.75 lb ai/acre). Maximum of one application per fallow.

- **Turfgrass (spray applications):** Application rates range from 1 to 2 lb ai/acre per treatment with a maximum of two applications per year.

- **Turfgrass (granular applications):** Application rates range from 1.5 to 2 lb ai/acre per application with a maximum of two applications per year. Label suggests a usual application rate of 1.5 lb ai/acre.

- **Sod in Florida (spray application)**: Application rate of 2 lb ai/acre for sandy soil and 4 lb ai/acre for muck soil for initial treatment. Follow up treatment is 1 lb ai/acre for sandy soil and 2 lb ai/acre for muck soil per treatment. Maximum of two applications per year.

- **Conservation Reserve Program Grasslands**: Application rates range from 0.75 to 2.0 lb ai/acre with a maximum of one application per year.

- **Macadamia Nuts:** Application rates range from 2 to 4 lb ai/acre per treatment. Treatments may be repeated as needed**.** Treatments are directed to the ground below the trees.

- **Guava:** Application rates range from 2 to 4 lb ai/acre per treatment. Maximum of three applications per year. Treatments are directed to the ground below the trees.

- **Sugarcane:** Application rate ranges from 2 to 4 lb ai/acre initial treatment with an application rate of 2 lb ai/acre for follow up treatment. Maximum of four applications per year or 10 lb ai/acre per year, with a maximum of two post emergence of the cane.

- **Roadsides:** Minimum and maximum roadside application rate supported by registrant is 1.0 lb ai/acre with a maximum of one application per year. Special local need (SLN) labels allow highway right-of-way application of several formulations at 1-2 lbs ai/acre.

Methods and Types of Equipment used for Mixing, Loading, and Application

Atrazine is applied by aerial spray, groundboom sprayer, tractor-drawn granular spreader, rights-of-way sprayer (or other truck-mounted sprayer), low pressure handwand sprayer, backpack sprayer, garden hose-end sprayer, lawn handgun sprayer, push-type granular spreader, or "belly grinder" granular spreader. There were no chemical-specific, PHED, or other data applicable to estimate the truck-mounted sprayer exposure.

Duration of Exposure

Based on multiple data sources, including BEAD and HED data (including USDA and Cal DPR) and the Agricultural Reentry Task Force surveys, estimates of duration of exposure have been made for the uses cited above. The duration of exposure for each activity is important in determining the appropriate toxicological endpoint to use for a risk assessment. For corn and sorghum, the amount of time spent planting, which corresponds to atrazine exposure duration is several weeks to over one month. The registrant has submitted information supporting an average handler exposure of 2 weeks per season. Little information was available for chemical weeding of sugarcane, but given the large acreages of sugarcane farms, it is anticipated that handler exposure durations of more than one week per season could occur. Lawn control operators (LCOs) are assumed to use atrazine granular or spray formulation seasonally 1-2

times per year per lawn and may be exposed over several weeks at a time, possibly more than 30 days per year. Golf course mixer/loader/applicators probably will not require more than one week to treat their courses, and few such courses are handled by commercial applicators. The turf use is restricted to St. Augustine and Bermuda grasses, which are limited to the southern United States and particularly Florida. Sod farmers may use atrazine more than twice per year as they raise and harvest sod continuously during the year, but it is unlikely they will apply atrazine for more than 1 week at a time. A limited amount of information was available for macadamia nuts and guava orchards, but based on their limited size, handlers are anticipated to spend less than a week at a time using atrazine. Of course, commercial handlers could cover several different crops and have exposures of several weeks in a row. For those persons, the corn and sorghum estimates will provide a high-end risk estimate. Because of the lack of data, the remaining scenarios, of potentially large acreage, including Christmas tree plantations, conifer forests, and rights-of-way spraying, will be assumed to be short- to intermediate in duration. It is acknowledged that there are small growers of most crops, but this risk assessment must be inclusive of the higher exposure duration activities within each crop in order to be adequately protective of most handlers.

ASSESSMENT/CHARACTERIZATION

Occupational Exposures and Risks

Handler Exposures & Risks

The Agency has determined that there are potential exposures to mixers, loaders, applicators, and other handlers during usual use-patterns associated with atrazine. Based on the use patterns, 15 major exposure scenarios were identified for atrazine:

(1a) mixing/loading liquid formulations for aerial application,
(1b) mixing/loading liquid formulations for groundboom application,
(1c) mixing/loading liquid formulations for rights-of-way sprayer application to roadside,
(1d) mixing/loading/incorporating liquid formulations onto dry and liquid bulk fertilizer (commercial off-farm technique)
(1e) mixing/loading/incorporating liquid formulations into dry bulk fertilizer (on-farm technique),
(2a) mixing/loading dry flowable formulations for aerial application,
(2b) mixing/loading dry flowable formulations for groundboom application,
(2c) mixing/loading dry flowable formulations for rights-of-way sprayer application to roadside,
(3) loading granular formulations,
(4) applying liquids with aircraft,
(5) applying liquids with groundboom sprayer,
(6) applying liquids to roadsides with rights-of-way sprayer,
(7) applying with a lawn handgun or compressed air sprayer,
(8) applying impregnated dry bulk fertilizer with a tractor-drawn spreader,
(9) applying granular formulations with a tractor-drawn spreader,
(10) mixing/loading/applying with a backpack sprayer,

(11) mixing/loading/applying liquid formulations with a low pressure handwand,
(12) mixing/loading/applying liquids with a lawn handgun or compressed air sprayer,
(13) loading/applying granulars with a push type spreader,
(14) loading/applying granulars with a bellygrinder, and
(15) flagging for aerial spray applications.

Handler Exposure Scenarios -- Data and Assumptions

Occupational handler exposure assessments are evaluated by the Agency using a baseline clothing exposure scenario and, if required, increasing levels of risk mitigation (PPE and engineering controls) to achieve a margin of exposure (MOE) which does not exceed the Agency's level of concern (see Toxicity Section). All of the submissions to the Agency have been reviewed and considered in preparing this risk assessment. The studies have been reviewed separately and are referenced in this document, with summaries appearing below. The assumptions used to calculate exposure estimates follow the study reviews.

Study Data

Agricultural Uses: The largest use of atrazine, and the largest potentially exposed worker population, involves the mixing and loading of formulation and spraying of row crops. Most of the occupational exposure studies submitted have measured exposure of these workers. These studies are described in detail below. The Novartis exposure data was collected from a several studies in the corn belt monitoring potential dermal and inhalation exposure to full time mixer/loaders and applicators. Studies used either passive dosimeters, urine biomonitoring, or both. All monitoring studies, except biomonitoring, reported residues in units of the parent compound, atrazine, only. The biomonitoring studies measured urinary chlorotriazines and back-calculated atrazine dose. One dosimetry study was submitted and reviewed by the Agency prior to this risk assessment, and was re-submitted in combination with the Agency's Pesticide Handler Exposure Database (PHED) values for ground applicators using enclosed systems. This was included as part of the risk estimates and compared to PHED-based estimates for agricultural handlers using closed systems, with close correlation. The Agency also reviewed an agricultural handler study (MRID 441521-09, -11) that included both passive dosimetry and biomonitoring of urinary metabolites of atrazine. Another study using biomonitoring to determine worker exposure (MRID 445976-05, -06) included over 100 replicates, but had significant study design and quality control issues. The PHED is used by the Agency as a surrogate chemical database for handler exposure values (see Table 3).

Agricultural Handler Study Summaries:

Handler studies incorporating biomonitoring

MRID 439344-17. *Evaluation of the Potential Exposure of Workers to Atrazine During Commercial Mixing, Loading, and Spray Applications to Corn. Biological Field Phase.* Honeycutt, R., Bennet, R., and DeGeare, M. (1996). HERAC, Inc. No. 95-501HE. Ciba Study No. 178-95. Unpublished study prepared by Ciba Crop Protection. 839 pages.

MRID 439344-18. *Assessment of Potential Worker Exposure to Atrazine During Commercial Mixing, Loading, and Application to Corn. Interim Report.* Selman, F. (1996). Lab Project Number: ABR-95133: 101930: 178-95. Unpublished study prepared by Ciba-Geigy Corp. 64 pages.

MRID 441521-09. *Evaluation of the Potential Exposure of Workers to Atrazine During Commercial Mixing, Loading, and Spray Applications to Corn. Final Report.* Selman, F.B. and L. Rosenheck (1996). Lab Project Number: ABR-95133. Unpublished study prepared by Ciba Crop Protection. 199 pages.

MRID 441521-11. *Evaluation of the Potential Exposure of Workers to Atrazine during Commercial Mixing, Loading, and Spray Application to Corn (EPA-Subpart U) -- Biological Field Phase. Final Report.* Honeycutt, R.C., Bennett, R.M. and DeGeare, M.A. (1996). Lab Project Number: 178-95: 95-501HE: 95-517. Unpublished study prepared by Ciba Crop Protection. 687 pages, 2 volumes.

MRID 443154-03. *Assessment of Potential Worker Exposure to Atrazine During Commercial Mixing, Loading, and Application to Corn (MRID 441521-09). Amendment 1.* Selman, F.B. and L. Rosenheck (1996). Laboratory Project Number ABR-95133. Unpublished study prepared by Novartis Crop Protection, Inc. 29 pages.

MRID 443154-04. *Presentation of Data from ABR-95133 "Assessment of Potential Worker Exposure to Atrazine During Commercial Mixing, Loading, and Application to Corn" from Use in the Pesticide Handler's Exposure Database (PHED 1.1).* Selman, F.B. and L. Rosenheck (1996). Laboratory Project Number ABR-97068. Unpublished study prepared by Novartis Crop Protection, Inc. 97 pages.

This study was conducted by Ciba-Geigy Corporation (now Syngenta Crop Protection) and was submitted to the Agency in several phases including interim reports, final reports, and amendments. The study monitored dermal and inhalation exposure experienced by workers during mixing, loading, and applying various atrazine-containing products to corn using ground boom sprayers. The study used passive dosimeters, air sampling, and biomonitoring of urine metabolite to determine daily workers exposures to atrazine. See **Table 4**.

Data were collected at 19 test locations: five in Illinois, five in Indiana, and nine in Ohio. Individual test "sites" consisted of either multiple fields treated with atrazine or commercial facilities where atrazine was loaded into carrier trucks or spray rigs.

Eighteen subjects (17 males, 1 female) were monitored, and one male subject was monitored twice, yielding nineteen replicates. Workers were monitored using dermal and inhalation dosimetry during the first two days of handling atrazine, while urine samples were collected prior to initiation of this study and during all three days of each monitoring period.

Applicators were responsible for driving the spray rigs, applying atrazine, and conducting maintenance of the spray rigs and booms. In addition, applicators occasionally cleaned spray rigs and coupled hoses from the trucks to the rigs. Applicators had between 3 and 15 years experience making pesticide applications. Of eleven applicator subjects, four were mixer/loader/applicators who handled and applied atrazine over a three day period while the remaining seven applied atrazine over a two day period. All but one of the applicators used closed cab tractors and all used groundboom sprayers. All mixer-loader/applicators used closed cab tractors and closed system mixing and loading except one who used open mixing and a closed cab sprayer.

The mixer/loaders dispensed atrazine products from bulk supply tanks into large nurse trucks using electronic valves and metering devices. When required, they would empty pesticide bags or jugs into the trucks to mix the spray solutions. The truck tenders were responsible for coupling and uncoupling hoses to and from trucks, driving the trucks, coupling truck hoses to spray rigs, and conducting occasional maintenance on the trucks and the rigs. All mixer-loader/truck tenders used closed mixing systems, except two who used open pour.

Clean protective clothing was worn by each test subject each day. The test subjects wore long sleeved shirts, long pants, leather boots and caps and some wore sweatshirts. Mixer/loaders and truck tenders also wore nitrile gloves and goggles.

A variety of commercial atrazine-containing products were used in the study. They are usually sold in bulk, mini-bulk, open pour containers, or bagged quantities, and are applied by commercial applicators only. The amount of atrazine in the end-use products ranged from 10.4 percent to 85.5 percent. Other active ingredients in these formulations include metolachlor, acetochlor, cyanazine, and dimethanamid. Atrazine application rates ranged from 0.95 to 1.98 lbs ai/acre

(mean= 1.4 lbs ai/A). The amount of atrazine sprayed for each replicate (over 2 or 3 day period) ranged from 148 lbs to 3,450 lbs of atrazine. Total acres treated per replicate (over 2 or 3 day period) ranged from 138 acres to 1,618 acres.

Dermal exposure was quantified using: (1) inner and outer body dosimeters, (2) hand rinses, and (3) head patches Inner body dosimeters including cotton undergarments (T-shirts (or bra) and briefs) were used to quantify dermal exposure to atrazine penetrating the workers' outer clothing. Outer body dosimeters consisted of 60/40 cotton: polyester blend, long-sleeved shirts and 100 percent cotton long pants. For replicates 1 to 10, sweatshirts (50/50 cotton:polyester blend) were used as outer dosimeters, and the long-sleeved shirts as inner dosimeters. Outer dosimeters were then sectioned for analysis.

Hand rinses were conducted both in a 200 ml detergent solution and in 200 ml distilled water. Head patches consisting of 16 ply 4 inch by 4 inch gauze with a cellulose backing were used to quantify face and neck exposure to atrazine. Two patches were pinned to a cap, one to the front, and one to the back. A face and neck surface area of 910 cm^2 was used for calculation of exposure.

Inhalation exposure was measured using personal air sampling pumps connected to Gelman mixed cellulose-ester filter-cassettes (for aerosols and particulates) and Chromosorb 102 vapor collection tubes (for vapors). The air flow rate was approximately 1.0 liter per minute. Pumps ran all day, from when subjects dressed, to their return from the field.

Two pre-screen urine samples, each covering a 12-hour interval (0-12 hour, and 13-24 hour), were collected from each participating subject prior to the study except for five volunteers. For these five test subjects, urine samples were obtained just prior to initiation of the study.

Urine samples were fortified with analytical grade atrazine and the expected four degradation products. One group of samples was stored under ambient conditions and one set was stored on wet ice. The recovery for the 120 hour ambient sample was 104 percent of the recoveries at time 0, and the recovery for the 120 hour wet ice sample was 85 percent of the time 0 wet ice samples.

Dermal and inhalation dosimetry samples were analyzed using mass spectrometric detection. The method used for urine biomonitoring analysis was a proprietary method (i.e. Novartis Analytical Method AG-637), which had previously been submitted to EPA in 1996 and validated in 1998.

Laboratory recovery data were collected concurrently with the field samples. Average recoveries from all matrices (e.g., dosimetry, air sampling media, hand rinses) ranged from 72 percent to 110 percent. Laboratory recoveries from urine averaged as follows: 107 percent for atrazine, 104 percent for G-30033, 106 percent for G-28279, and 91 percent for G-28273.

For dermal and inhalation exposure, fortified field matrix samples were prepared on twelve separate days throughout the study. The stock solution was prepared that day from aliquots of the pesticide formulation collected from the bulk storage tanks at the test-sites.

The fortified field matrix recoveries were quite inconsistent. Field fortification levels for the dermal dosimeters ranged from 5.8 micrograms up to 48,000 micrograms. Field recoveries ranged from 21.9 percent to 230 percent. Fortification levels for the hand rinses ranged from 13 micrograms to 4,800 micrograms. The field recoveries for the hand rinses was 17.6 percent to 153 percent. The fortification levels for the inhalation media ranged from 1.16 micrograms to 120 micrograms. The field recoveries for the airborne samples was 22.6 percent to 254 percent for the Gelman air filters and 57.6 percent to 112 percent for the Chromosorb tubes.

Fortified urine and control urine samples were prepared using aliquots of control urine spiked with analytical grade atrazine and four degradation products (atrazine mercapturate, G-30033, G-28279, and G-28273). Average recoveries ranged from 97 percent to 120 percent.

Three sets of data are reported in the study: (1) dose as a function of inhalation monitoring and dermal dosimetry data, (2) dose predicted from urinary concentration, and (3) dose predicted from surrogate pesticide exposure data (i.e., PHED). The authors used the following assumptions to calculate exposure:

- each worker handled 6,000 lbs. atrazine per year for the purposes of calculating an ADD;
- each worker weighed 70 kg and had a 35 year exposure to atrazine over a 70-yr lifetime;
- the three chlorotriazine metabolites represented total chlorotriazines in urine;
- a dermal absorption value of 5.6 percent was selected by the registrant; and
- an adjustment factor (100/12) was used when calculating atrazine dose from urine, based on a monkey and human studies. This indicates that 12 percent of an atrazine dose could be accounted for in 0-24 hour urine samples as total chlorotriazine metabolites.

The internal "unit exposure" atrazine value calculated from urine data was derived by summing total chlorotriazines exposure per monitoring period multiplied by the adjustment factor (100/12) and dividing the result by the total pounds of atrazine handled in the monitoring period. Only the three chlorotriazine metabolites (G-28273, G-28279, and G-30033) were combined to calculate the atrazine dose.

Dermal exposure was calculated from residue levels representing "exposure to the skin." Inner layer dermal dosimeter values were used whenever possible. A 10 percent penetration factor, was used to calculate inner layer exposur values where these values were missing. The calculated dermal values were then combined with hand rinse and head patc data to give total atrazine exposure. Next, the inner layer residue values were multiplied by the registrant selected dermal absorption factor (5.6%) to yield absorbed dose. Inhalation exposure was estimated by multiplying the monitored air concentration by 29 liters per minute, and dividing by the total amount of atrazine handled. An absorption factor of 100 percent was assumed.

The data submitted in the study of worker exposure to atrazine meet most of the criteria specified by the U.S. Environmental Protection Agency's (US-EPA) OPPTS Series 875, Occupational and Residential Exposure Test Guidelines, Group A: Applicator Exposure Monitoring Test Guideline (875.1100, Dermal exposure: outdoor; 875.1300, Inhalation exposure: outdoor; 875.1500, Biological monitoring).

- Exposure data were not corrected for field, storage, or laboratory recovery rates. Field fortification recoveries were highly variable. This variability may be due to non-homogeneity of the pesticide suspensions sampled. Th study suggests that this variability in the field fortification recoveries is most likely due to the use of formulated material sampled from bulk containers for spiking, since that as the suspension is serially diluted, any non-homogeneity is amplified with each step.

- Another significant issue was the choice of urinary total chlorotriazine residues for biological monitoring. The chlorotriazine residues represent only 12% of total atrazine dose. It is HED policy that the predominant metabolite be used as the indicator for calculating the parent chemical, thereby reducing the error potential when back-calculating the dose. It is preferable to use a metabolite which represents 30% or more of the original dose, in order to reduce statistical error. The primary metabolite is atrazine mercapturate, which has been used in other monitoring studies, including the current National Hazardous Exposure Assessment Survey (NHEXAS). The authors state that at the time of the study they were limited to the chlorotriazine residues due to a lack of an analytical method for atrazine mercapturate. Also, urine creatinine and creatinine clearance were not measured . Without these measures, there is no way to verify the accuracy of the volume of urine collected during biomonitoring (which is critical to calculating the total dose absorbed).

- Five of the subjects handled simazine products as well as atrazine. Simazine interferes with quantification of atrazine and its metabolites in urine. It is not known whether cyanazine also interferes.

- Calibration of some of the application equipment was not performed.

The study presented the following results.

Applicators: Seven applicators were monitored for two days (dermal dosimetry and inhalation monitoring), which resulted in 14 passive dosimetry replicates. At least three of these applicators had spill-related exposure. The total dose (i.e., dermal + inhalation) ranged from 2.10 x 10^{-2} to 6.42 x 10^{-5} mg/lb a.i. (geometric mean of 7.71 x 10^{-4} mg/lb a.i.). Urinary residues indicated an oral equivalent dose ranging from 7.87 x 10^{-3} to 8.61 x 10^{-5} mg/lb a.i. (geometric mean of 6.05 x 10^{-4} mg/lb a.i). The PHED dose estimate was 2.67 x 10^{-4} mg/lb a.i., assuming closed cab, ground boom application, long pants, long sleeves, and no gloves.

Mixer-Loader/Truck Tenders: Seven mixer-loader/truck tenders using closed mixing systems and one using an open system were monitored for two days (dermal dosimetry and inhalation monitoring), which resulted in 14 passive dosimetry replicates. The total dose (i.e., dermal + inhalation) ranged from 1.63 x 10^{-2} to 1.49 x 10^{-5} mg/lb a.i. (geometric mean = 7.34 x 10^{-4} mg/lb a.i., excluding MLA-20 who used an open mixing system). Urinary residues indicated an oral equivalent dose ranging from 2.53 x 10^{-3} to 2.76 x 10^{-5} mg/lb a.i. (geometric mean = 3.77 x 10^{-4} mg/lb a.i.) The PHED dose estimate was 6.68 x 10^{-4} mg/lb a.i., assuming closed mixing/loading systems, long pants, long sleeves, and gloves.

Mixer-Loader/Applicators: Ten mixer-loader/applicators using closed mixing/closed cab systems and one using an open mixing/closed cab system were monitored for two days (dermal dosimetry and inhalation monitoring), which resulted in 6 passive dosimetry replicates. The total dose (i.e., dermal + inhalation) ranged from 1.55×10^{-2} to 1.68×10^{-5} mg/lb a.i. (geometric mean of 1.29×10^{-3} to 1.03×10^{-3} mg/lb a.i.). Urinary residues indicated an oral equivalent dose ranging from 1.03×10^{-3} to 4.59×10^{-3} mg/lb a.i. The PHED-based dose was 9.35×10^{-4} mg/lb a.i.

The study also presented Lifetime Average Daily Doses (LADD) values. These results are not presented here because there is currently no cancer concern with atrazine.

Apparently the PHED data were subsetted in a manner that was not explained in the study report. Therefore the results were lower than HED's estimates using closed mixing and loading or enclosed cab spraying with a ground boom. The HED also attempted to calculate the passive doses and urinary excreted doses using the data from the studies. The HED calculations were within the higher range of the study authors' values, and agreed closely with PHED-based calculations for scenarios using engineering controls. This is discussed further in the risk estimates section.

MRID 445976-05. *Evaluation of the Potential Internal Dose of Atrazine to Workers During Mixing-Loading and Application of Atrazine Products – Biological Monitoring.* Selman, F.B. (1998). Novartis Laboratory Number 179-95. ABR-97094. Unpublished study prepared by Novartis. 182 pages; and

MRID 445976-06. *Evaluation of the Potential Internal Dose of Atrazine to Workers During Mixing-Loading and Application of Atrazine Products – Biological Field Phase.* Honeycutt, R.C. and M.A. DeGeare. (1998). Novartis Laboratory Number 179-95. Unpublished study prepared by Novartis. 912 pages.

This study was submitted to the Agency in two reports. The purpose of the study was "to determine the amount of atrazine that individuals who mix, load, and apply atrazine are exposed to during commercial treatment of corn" in the course of realistic normal daily activities. The study focused on the biomonitoring of metabolites of atrazine in urine samples. However, the authors stress that this study was "not designed to be the traditional Subdivision U worker exposure study." The basic premise of the study was the assumption that worker exposure values obtained reflected steady-state exposure conditions.

This study consisted of an analytical component and a biological field component. The analytical phase was managed by Novartis Crop Protection (formerly Ciba-Geigy) and the biological field phase (urinary biomonitoring and an atrazine seasonal usage survey) was managed by HERAC, Inc. The study began in March 1995 with urine samples being taken through June of 1995. These samples were analyzed two years later in April, 1997. The analytical phase report was completed June 29, 1998.

Sixteen end-use products were used by study subjects. All are usually sold in bulk, mini-bulk, open pour containers, or bagged quantities, and are applied by commercial applicators only. The identity, strength, purity and composition of each end-use product was not independently analyzed; products used were commercial formulations obtained from the open market. The percent atrazine ranged between 10 percent and 85.5 percent. Most end-use products (14/16) contained varying percentages of one of the following herbicides: metolachlor, bromoxynil, alachlor, acetochlor, cyanazine, bentazon, dicamba, propachlor, and dimethanamid.

Application rates ranged between 0.14 lbs ai/A and 2.01 lbs. a.i./A (average = 1.3 lbs a.i./A). [The maximum pre-emergent application rate for atrazine is 2.0 lbs a.i./A; the annual treatment limit is 2.5 lbs a.i./A.] Applications were performed with groundboom sprayers by experienced applicators (mean: 8 years experience; range: 0.25 to 40 years). All but four applicators used closed-cab application equipment. In those four instances, open-cab tractors with trailing groundboom sprayers were used.

Use information was identified by "spray tickets" provided by the commercial applicator facilities. Spray tickets contain information on the product applied as well as the application rate on a given date, and identify the applicator receiving an allotment of atrazine for later application at a farm. Data were available for 107 volunteer subjects.

The number of test subjects is inconsistently reported within the study. The Analytical Phase report indicated that 122 individual subjects monitored (with 9 monitored twice) yielding 131 replicates. The Biological Field Phase report indicates original 131 subjects distributed as 15 mixer/loaders, 96 mixer/loader/applicators, 10 applicators, 6 truck tenders,

and 4 mixer/loader/truck tenders. Appendix 3 of the Analytical Phase Report reports personal information for 130 study subjects and indicates that 10 subjects were monitored twice, no urine samples were obtained from 2 subjects and one subject did not handle atrazine. This would indicate that 117 test subjects participated (130 - 10 -3 = 117). Appendix 7 of the Analytical Phase Report, "Summary of Atrazine Seasonal Use Data," lists 107 volunteer subjects for which seasonal atrazine use data were available including 9 mixer/loaders, 83 mixer/loader/applicators, 9 applicators, 2 truck tenders, 4 mixer/loader/truck tenders.

Similarly, the number of urine sample replicates is inconsistently reported. The Analytical Phase report states that 91 urine sample replicates from five states were analyzed (15 to 22 samples from study sites in Indiana, Ohio, Iowa, Illinois, and Nebraska). The Biological Field Phase report indicated that 138 urine sample replicates were collected (127 complete samples plus an extra 11 replicates). Of these, 35 were disqualified (19 due to lack of verified atrazine use and 16 because atrazine was definitely not handled concurrently with urine collection. This yielded 103 urine sample replicates for analysis. Appendix 9 of the Analytical Phase report lists 125 replicates.

A urine sample "replicate" is defined as all urine collected during "the period of time from initiation of the first urine sample for a volunteer through sampling of the last urine sample from that volunteer." Workers were sampled over varying periods of time, and a urine sample replicate grouping always involved numerous individual analyses (e.g., for one worker, a replicate grouping consisted of 18 separate urine analyses over the time period). Two random urine pre-screenin urine samples were collected from most test subjects prior to the start of their 1995 spray season. However, the authors stated that it was "possible that the volunteers could have been working with atrazine before or during this pretrial period.

Test subjects handled atrazine from one to seven consecutive days, with most test subjects handling atrazine one (25.2 percent), two (27.2 percent) or three (28.2 percent) days. No attempt was made to standardize clothing worn by subjects or to alter or interfere with any subject's normal work practices. Subjects typically wore various combinations of rubber or leather work boots, chemical resistant gloves, and goggles (mixer/loaders and truck tenders only), long sleeved shirts, long pants, and jackets.

The study was conducted in compliance with most OPPTS Series 875 Occupational and Residential Exposure Test Guidelines, Group A: Applicator Exposure Monitoring. The most significant study quality issues follow.

- Potential interference from other active ingredients was not addressed. This is significant since handlers used sixteen different atrazine products, fourteen of which contained substantial percentages of one of eight other herbicides, and two of which contained another triazine (e.g., cyanazine).
- Formulation sample aliquots or tank mix aliquots were not analyzed.
- The number of test subjects that were actually monitored in the study is unclear.
- Pre-screen urine samples were not obtained for all test subjects. Further, creatinine was not analyzed in the urine samples, preventing evaluation of the completeness of the 24-hr urine samples.
- Analytical data for two of the three atrazine metabolites quantified were not corrected for laboratory storage recovery, which ranged between 57 percent and 78 percent.
- An incomplete set of the field collected urine samples were analyzed (91samples analyzed out of 103 qualified samples).

Overall quality assurance / quality control techniques were acceptable. Sample storage and handling procedures were acceptable. No formulation tank mix samples were analyzed. The analytical method used was proprietary (i.e., Novartis Analytical Method AG-637), which had been submitted to The Agency in 1996 and validated in 1998. The LOD was 0.05 ng for each analyte. The LOQ was 1.0 ppb for atrazine and G-30033 and 2.0 ppb for G-28279 and G-28273.

A proprietary method (Novartis AG-637) was used to quantify three atrazine chlorometabolites in urine samples. The daily dose for atrazine was calculated by combining the highest level found of the three chlorometabolite levels (ng/g grams urine) found during any single 24-hour monitored period, multiplied by a 100/12 accountability factor derived from human and animal metabolism studies. This value was divided by the subject's body weight. The Average Daily Dose (ADD) was calculated by multiplying the Atrazine Daily Dose times an assumed spray season of 30 day/year and divided by 365 days/yr. The Lifetime Average Daily Dose (LADD) was calculated by multiplying the ADD times (35 years/70 year lifetime).

The study did not correct G-30033 and G-28279 data for laboratory, storage, or field recovery losses, however, a correction factor of 0.75 was applied to G-28273 data. This factor was reportedly derived from the "average recovery... across all four sets of stability data..." and was calculated by averaging: 1) field fortification recovery (77 percent); 2) stability after 120 hours exposure to ambient (85.5 percent) or wet ice (77.5 percent) conditions; 3) laboratory storage recovery (57 percent at Day 730); and 4) stability of "incurred" residues (75 percent).

The study used submitted data from monkey (one IV and one oral) and human (one dermal and one oral) dosing studies to determine the most appropriate factor to apply to total chlorotriazine residues in 0-24 hour urine samples to calculate the internal dose of atrazine. The study reported that parent atrazine was generally non-detectable in urine after dosing. Therefore, the study did not include atrazine with chlorotriazine metabolites in those samples where it was detecte in urine, since its presence in urine was likely to be artifactual or due to sample contamination. Only the oral dosing studie proved useful and there was some agreement between monkey and human oral studies. The three chloro degradation products of atrazine (G-30033; G-28279; G-28273) were found to represent between 11 percent and 12 percent of the total dose excreted in 0-24 hour urine samples. The correction for the various molecular weights relative to the parent compound atrazine, was included in the percent excretion in urine calculated by Cheung, et al.

Atrazine daily dose was calculated by combining the highest level of the three chlorotriazine metabolite levels (ng/g x grams urine) found during any single 24-hour period (after dividing the G-28273 data by 0.75), multiplied by the 100/12 accountability factor, to yield mg/day, then dividing by the body weight of the subject. No attempt was made to subtract a background atrazine level since the study premise was to measure steady-state urinary atrazine metabolite levels The atrazine daily dose value was then converted to an Average Daily Dose (ADD) by assuming a spray season consisted of 30 days of exposure per year (365 days). The ADD was multiplied by 35/70 to account for number of years worked and years of life.

The study reported the following findings.

- Of the samples analyzed, 6 percent contained atrazine residues. Since atrazine is metabolized and not present in urine, it was assumed that this finding was due to poor personal hygiene.
- None of the workers handled atrazine products continuously throughout the spray season.
- Open-cab application was practiced by only two of the subjects and their exposures were of similar magnitude to that from closed cab applicators. These data were pooled.
- The Average Daily Dose ranged from 3.98×10^{-4} to 6.37×10^{-3} mg/kg/day for applicators, 5.73×10^{-4} to 3.84×10^{-2} mg/kg/day for mixer/loader/truck tenders, and 4.67×10^{-4} to 4.91×10^{-2} mg/kg/day for mixer/loader/applicators.
- The Lifetime Average Daily Dose (LADD) was 0.62×10^{-4} mg/kg/day for applicators, 1.81×10^{-4} mg/kg/day for mixer/loader/truck tenders, and 2.38×10^{-4} mg/kg/day for mixer/loader/applicators.

The HED reviewers recalculated the absorbed daily dose using the mean daily maximum exposure for individual workers and for each job category (i.e., mixer/loader, applicator, and mixer/loader applicator). Most replicates (n = 96) fell into the mixer/loader/applicator category. The amount of ai handled per day, calculated by the authors, varied from a minimum of 4.5 lbs to a maximum of 772 lbs for mixer/loaders, and average amount ai handled ranged from 133 lbs for applicators to 241 lbs for mixer/loaders. On review, the amount of ai handled, based on actual "spray tickets" reported ranged from 4.5 to 770 lbs ai per day for mixer/loaders, from 58 to 310 lbs ai per day for applicators and from 45 to 364 lbs ai per day for mixer/loader/applicators. As indicated by the amounts handled per day, the dose was not found to be "steady state," as suggested by the authors. Also, due to collection of 24 hour urine samples during the spray season, it was not possible to determine the relationship between the amount handled on a given day and the chlorotriazines excreted the following day. The mean 90^{th} percentile daily dose was selected to represent a daily dose for each category. This is considered a reasonable, yet high daily value as the study monitored actual work practices without influencing amounts of atrazine handled. The HED calculation showed internal doses of 0.012 mg/kg/day for mixer loaders, 0.0038 mg/kg/day for applicators, and 0.014 mg/kg/day for mixer/loader applicators. These doses are within the same range as the study findings. The HED calculation is only approximate, however, because during the study, atrazine was handled on consecutive days (or not at all), and atrazine is excreted in the urine in quantifiable amounts for at least 3 days after exposure. Some of the highest daily doses were based on days when little or no atrazine was handled. Therefore, there is both the "lag time" to excretion, and the additive nature of

consecutive daily doses. Use of the single 24-hour excretion correction of 12% for chlorotriazines does not correct for either of these major confounding factors. Atrazine metabolites continue to be excreted for several days after exposure, so measuring the daily excretion only provides data about the body burden at that time. Therefore, for the purpose of interpreting this study, the mean to 90th percentile of the maximum doses are considered most representative for each job category for calculating MOEs for handlers. Although the dose per reported pounds ai handled was also calculated, for the purpose of comparison to PHED computations, this number has greater uncertainty than using the actual daily dose based on study data alone. See Table 4 for estimates of exposure and MOEs based on the uncorrected field data.

In the report entitled *Presentation of Data from ABR-95133 "Assessment of Potential Worker Exposure to Atrazine During Commercial Mixing, Loading, and Application to Corn" for Use in the Pesticide Handler's Exposure Database* (MRID 443154-04), Novartis added the data from MRID 441521-09 to their copy of PHED V 1.1. The resulting unit exposure values (i.e., PHED V1.1 plus additional data from the corn worker monitoring study - MRID 44152109) for mixer/loaders using closed systems and ground applicators using enclosed cabs were used in the occupational handler exposure/risk assessment calculations presented in Table 8. These scenarios have also been assessed using the standard PHED V1.1 unit exposure values.

Turf Uses:

MRID 430165-06: Rosenheck, L.; Phillips, J.; Selman, F. (1993) Worker Mixer/Loader and Applicator Exposure to Atrazine: Lab Project Number: AE/91/511: 126/91. Unpublished study prepared by Pan-Agricultural Labs, Inc. 309 p.

This study was submitted by the registrant to support the re-registration of atrazine for use on turf. This study focused on mixer/loader and applicator exposures from two formulations – a 90 percent active ingredient water-dispersible granule formulation applied as a spray and a 1.7 percent active ingredient granular formulation (fertilizer combination). Fou different scenarios were characterized in the study: 1) Home use push-type cyclone spreader lawn treatment, 2) Home use "hand cyclone spreader" lawn treatment, 3) LCO mixing/loading and "handgun" spray application to client lawns, and 4) Golf course caretaker mixing/loading and "handgun" spray application. The study was conducted at three different sites, with each scenario represented.

Dermal exposure was monitored by using 100 percent cotton long underwear as whole body dosimeters, worn underneath work clothing. Exposure to hands, face, and neck was estimated by hand washes and face/neck swipes. Inhalation exposure was monitored using personal air-sampling pumps attached to glass fiber filters. Controls and two fortification samples were run concurrently with each set of field samples. Field recovery levels ranged between 61.5 percent to 98.2 percent.

The study met the criteria of most of the Subdivision U guidelines. The only deviation from these guidelines was that the study used an application rate slightly lower than the current maximum label rate.

Although this study is chemical-specific to atrazine, it was originally submitted under the data call-in which provided much of the data for the PHED. Therefore, this study data has been used for risk assessments for other pesticide active ingredients which had lawn-care handgun, push-spreader, or belly grinder application methods. Subsequent ORETF studies, described below, contained more replicates for each type of handler exposure scenario, but the belly grinder was not included. This study also monitored the exposure of mixer/loaders for spraying separately from the applicators, while commercial lawn care operators (LCOs) commonly mix, load and apply pesticides. Therefore, the only way to estimate

combined exposure using this study would be addition of the individual exposures, which may be an overestimation. For the lawn hand-gun spray, the unit exposures derived from the data in this study are similar to the data in the ORETF surrogate exposure study (OMA002). The push-spreader unit exposures in the atrazine study are several times higher than those in the ORETF study OMA001, for the same level of protective clothing. The atrazine study had fewer replicates (15 *vs*. 40) and handled less ai (approx. 1 lb *vs*. 3 lb) than the ORETF study, so extrapolation may account for some of the magnitude of the difference (assuming that the more material handled, the lower the exposure/lb handled as some of the material falls or rubs off).

The Outdoor Residential Exposure Task Force also submitted exposure studies to the Agency for either occupational or non-occupational residential applicator exposure under MRID 449722-01. Those studies include application of granular formulations by push-spreader (OMA001), profession lawn care operators using truck-mounted hoses with hand-gun controlled spray (OMA002), resident-applicator using a granular push spreader (OMA003), and resident-applicator using a hose-end spray (OMA004).

Surrogate chemicals were chosen by the Task Force for their representativeness based on physical chemical properties and other factors. Dacthal, which was the surrogate chemical used for the granular spreader and low-pressure hand gun sprayer studies, has a molecular weight of 331.97 and a vapor pressure of 1.6×10^{-6}, and is believed to be an appropriate surrogate for atrazine. These studies have been reviewed by Health Canada and use of the data are being considered by the Agency. For comparison purposes, the ORETF data (geometric mean) values were also used to calculate MOEs for applicable scenarios. See Table 10.

Other Studies submitted but not used for calculated exposure/risks in this document:

MRID 441521-06. *An Updated Assessment of Worker Exposure for Atrazine in Response to the U.S. Environmental Protection Agency Issuance of the "Triazine Herbicides Position Document 1. Initiation of Special Review."*

Supplement to ABR-95038: Assessment of Worker Exposure for Atrazine in Response to the U.S. Environmental Protection Agency Issuance of the "Triazine Herbicides Position Document – Initiation of Special Review" (MRID 435986-38). Laboratory Project Number: ABR-96071. Unpublished study by Ciba Crop Protection. 124 pages.

This submission by Ciba-Geigy Corporation estimates annual dose, average (amortized) daily doses (ADD), and lifetime average daily doses (LADD) for atrazine mixer-loaders and applicators. The estimates were based on dermal absorption values from human studies, use information from proprietary data bases (e.g., Maritz Marketing Research, Doane Marketing Research) and the 1987 Census of Agriculture, and dermal and inhalation unit exposure data from the Pesticide Handlers Exposure Database (PHED, version 1.1).

This submission essentially duplicates many of the occupational and residential assessments contained within th occupational and residential exposure assessment chapter. It is not evaluated further as it is based on information that is n current.

MRID 439344-15. *Preliminary Risk Characterization for Atrazine and Simazine.* Sielken, R., R. Bretzlaff, and C. Valez-Flores. (1996). Lab Project Number: 56. Unpublished study prepared by Sielken, Inc. 1254 pages.

This non-guideline submission was in response to EPA's Position Document 1 (PD1) announcing the initiation o Special Review of the triazines herbicides atrazine, simazine, and cyanazine. The purpose of the study was to use simulated probability distributions to characterize exposure from the two triazines arising from water, diet, and occupationa sources. Distributions on the lifetime average daily dose (LADD) from these sources were developed and were presented a margin-of-exposure assessment as a percent of the reference dose (RfD – reported as 0.005 mg/kg/day). The remainder o this summary focuses on the atrazine occupational handler exposure assessment and does not consider the extensive drinking water, dietary exposure or combined exposure pathway assessments, nor does it consider any of the simazine assessments.

The assessment was crop specific and various sub-populations based on vegetation management, commercial so production, residential lawn care (both commercial and homeowner) were examined. The worker atrazine exposure assessments were conducted for all combinations of the following:

- Growers and commercial handlers;
- Mixer/loaders, applicators, and mixer/loader/applicators;
- Aerial and ground application methods; and
- Two formulations – emulsifiable concentrates and water dispersible granules.

The surrogate exposure assessment utilized registrant supplied atrazine usage data and exposure data from the Pesticide Handlers Exposure Database. A major departure was made from the assessments typically conducted by the Health Effects Division in that distributional unit exposures were developed from PHED data based on ten body parts. Monte Carlo simulation techniques were used to combine all of the variables in the pesticide handling exposure equations

These analyses reportedly indicate that the percent of the RfD corresponding to the estimated LADD is almost always less than 10 percent and frequently much less than 10 percent. The 50th percentile of all of these distributions are reported to be less than approximately 0.1 percent.

MRID 441521-08. *Supplemental Data and Evaluation of Exposure to Lawn Care Operators Using Atrazine in the Southern United States*. Selman, F.B. (1996). Supplement to ABR-95038: Assessment of Worker Exposure from Atrazine in Response to the U.S. Environmental Protection Agency Issuance of the "Triazine Herbicides Position Document – Initiation of Special Review" (MRID 435986-38). Laboratory Project Number: ABR-96069. Unpublished study by Ciba Crop Protection. 13 pages.

This submission was in response to the Agency's Position Document 1 (PD1) announcing the initiation of Specia Review of the triazines herbicides atrazine, simazine, and cyanazine. The submission focused on the risks to Lawn Care Operators from the use of atrazine on residential lawns. This submission is not reviewed further as it is a partial duplication of the residential exposure assessment contained in this chapter and is based on outdated use information.

MRID 445976-04. *Comparison of Exposure Assessments to Atrazine and Simazine for Commercial Operators and Farmers who Mix, Load, and/or Apply Atrazine.* Selman, F.B. (1998). Novartis Laboratory Number 542-98. ABR-98068. Unpublished study prepared by Novartis. 16 pages.

This submission was in response to The Agency's Position Document 1 (PD1) announcing the initiation of Special Review of the triazines herbicides atrazine, simazine, and cyanazine. This submittal attempts to establish the equivalence of the methodologies used to calculate the exposure assessments for atrazine and simazine. This submission i not reviewed further as it is a partial duplication of the occupational exposure assessment contained in this chapter and is based on outdated use information. However, it should be noted that this submission indicates that the worker exposure assessment based on the Pesticide Handlers Exposure Database (PHED version 1.1) and a large scale monitoring study of atrazine exposure conducted during normal agricultural practices yield exposure estimates within one-half order of magnitu for all work functions.

Pesticide Handler Exposure Database

In this assessment potential agricultural worker exposures to atrazine were calculated using surrogate values from the *Pesticide Handlers Exposure Database (V 1.1)* (PHED) and for **two** major agricultural handler scenarios the potential exposure was also estimated using PHED values enhanced with Novartis- submitted worker exposure monitoring data. The Agency uses PHED as a primary source of surrogate exposure data because the data contained in the system have undergone an extensive quality control/quality assurance review process as has the system itself (i.e., values calculated using PHED can be considered reliable based on the data included in the system).

PHED was designed by a task force consisting of representatives from the U.S. EPA, Health Canada, the California Department of Pesticide Regulation, and member companies of the American Crop Protection Association. PHED is a generic database containing measured exposure data for workers involved in the handling or application of pesticides in the field (i.e., currently contains data for over 2000 monitored exposure events). The basic assumption underlying the system is that exposure to pesticide handlers can be calculated using the monitored data as exposure is primarily a function of the physical parameters of the handling and application process (e.g., packaging type, application method, and clothing scenario). PHED also contains algorithms that allow the user to complete surrogate task-based exposure assessments beginning with one of the four main data files contained in the system (i.e., mixer/loader, applicator, flagger, and mixer/loader/applicator).

Users can select data from each major PHED file and construct exposure scenarios that are representative of the use of the chemical. However, to add consistency to the risk assessment process, the Agency, in conjunction with the PHED task force has evaluated all data within the system and developed a surrogate exposure table that contains a series of standard unit exposure values for various occupational exposure scenarios (*PHED Surrogate Exposure Guide of August, 1998*). These standard unit exposure values are the basis for this assessment. The standard exposure values (i.e., the unit exposure values included in the exposure and risk assessment tables) are based on the "best fit" values calculated by PHED. PHED calculates "best fit" exposure values by assessing the distributions of exposures for each body part included in datasets selected for the assessment (e.g., chest or forearm) and then calculates a composite exposure value representing the entire body. PHED categorizes distributions as normal, lognormal, or in an "other" category. Generally, most data contained in PHED are lognormally distributed or fall into the PHED "other" distribution category. If the distribution is lognormal, the geometric mean for the distribution is used in the calculation of the "best fit" exposure value. If the data are an "other" distribution, the median value of the dataset is used in the calculation of the "best fit" exposure value. As a result, the surrogate unit exposure values that serve as the basis for this assessment generally range from the geometric mean to the median of the selected dataset.

Table 3 summarizes the caveats and parameters specific to the surrogate data used for each scenario and corresponding exposure/risk assessment. These caveats include the source of the data and an assessment of the overall quality of the data. The assessment of data quality is based on the number of observations and the available quality control data. The quality control data are based on a grading criteria established by the PHED task force.

Assumptions

The following assumptions and factors were used in order to complete this exposure assessment (references follow the text portion of this document):

- The average body weight of an adult handler was assumed to be 70 kg when the toxicity endpoint is not sex specific. A 60 kg body weight was used in assessments involving developmental studies.

- Exposure Factors: The ratio of the body surface area used in dermal calculations to the body weight to estimate potential dose overestimates by a factor of 1.1. The ratio is not physiologically matched in that the surface area is for an average male while the body weight is the median for both male/female. The reduction factor would increase a dermal MOE from 8 to 9 or 90 to 100. HED has agreed to use the NAFTA recommended values for breathing rate rather than the existing rate in Series 875 Group A (i.e., previously known as Subdivision U). Series 875 Group A recommends an inhalation rate of 29 L/min. The new NAFTA recommended inhalation rates are 8.3, 16.7, and 26.7 L/min for sedentary activities (e.g., driving a tractor), light activities (e.g., flaggers and mixer/loaders < 50 lb containers), and moderate activities (e.g., loading > 50 lb containers, handheld equipment in hilly conditions), respectively. These inhalation reduction factors are 3.5 for tractor drivers, 1.7 for mixer/loaders and flaggers, and 1.1 for handheld equipment. These changes in exposure factors will be programmed in PHED V2.0 and are characterized here for regulatory risk management decisions.

- Average work day interval represents an 8 hour workday (e.g., the acres treated or volume of spray solution prepared in a typical day).

- Daily acres and volumes (as appropriate) to be treated in each scenario include the following typical to high-end estimates:

  -- 1,200 acres as the high-end estimate for aerial application to crops designated as "high acres" (i.e, corn, sorghum, fallow lands, and conservation reserve program grasslands)

  -- 350 acres as the high-end estimate for aerial application to sod farms and as a rangefinder estimate for forestry, corn, sorghum, conifer forests, fallow lands and conservation reserve program grasslands)

  -- 450 acres as the estimated 75th percentile of the registrant-submitted study data of corn/sorghum handler daily acreage for ground application

  -- 200 acres for median estimate for groundboom applications to high acre crop,

  -- 80 acres for ground (spray and granular) applications to non-high acre crops (i.e., sod farms, Christmas tree farms, macadamia nuts, guava, sugarcane),

-- 40 acres for ground (spray, rights-of-way, and granular) applications to golf courses, roadsides, and Bermuda grass highway rights-of-way;

-- 350 acres per day for flagging to support aerial spray applications;

-- 960 tons per day of dry bulk fertilizer mixed and loaded per day with special closed system equipment; and

-- a range of 143 to 500 acres treated per day with dry bulk fertilizer impregnated with atrazine using ground equipment. The acreage covered is dependant on practical limitations based on the pounds applied per acre.

– mixer/loaders for LCO applicators for lawn treatments with hose-end spray guns were estimated to support 20 trucks, with each LCO spraying an estimated 5 acres per day, based on ORETF and industry information.

- Calculations are completed at the maximum application rates for specific crops as stated on available atrazine labels. The acreages treated and quantities handled were confirmed by the data submitted in several agricultural handler studies. As noted above, some of the acreages cited in the studies were significantly higher than the Agency's estimate of a daily upper-bound limit, so the 75th percentile of those higher acreages was also included in relevant scenarios, in an effort to create as realistic exposure estimates as possible. Pesticide usage data were provided by the registrant concerning the actual "typical" application rates that are commonly used for atrazine at the SMART meeting in 5/99, and the Biological and Economic Analysis Division (BEAD) generated a Quantitative Usage Analysis (QUA, 5/10/99). Typical or average rate were well correlated between these two primary sources for major crops and were included in the exposure and risk estimates. The average or typical rates will be useful when considering risk mitigation, where risk estimates performed at the label rate exceed the level of concern.

- Due to a lack of scenario-specific data, HED sometimes calculates unit exposure values using generic protection factors (PF) that are applied to represent various risk mitigation options, such as the use of personal protective equipment (PPE) and engineering controls). PPE protection factors include those representing a double layer of clothing (50 percent PF), chemical resistant gloves (90 percent PF) and respiratory protection (80 percent PF) for use of dust/mist mask or a 90 percent PF for use of an organic vapor removing mask. Engineering controls are generally assigned a PF of 80 to 98 percent, depending on the scenario of concern. For example, engineering controls for loading dry formulations assumed a closed loading system would provide a 98% PF.

Certain atrazine labels contain instructions for impregnating or coating dry bulk granular fertilizer with atrazine for application to corn or sorghum. According to the information provided to HED, for commercially prepared dry bulk fertilizer impregnated with atrazine there is a division of labor, in that most

commercial dealers, even small dealer operations, usually have different individuals running the mixing equipment and applying the mix to fields. This is because of the different skill requirements and for the sake of productivity. Thus for commercial dry bulk fertilizer preparation, HED performed separate assessments for mixer/loaders, and applicators. If an individual were to mix/load and apply, then the risk would increase correspondingly. However, for on-farm dry bulk fertilizer impregnation, HED assumes that one handler mixes, loads, and applies the fertilizer/atrazine mixture. One person would be expected to handle less fertilizer and atrazine in a day than would a team.

HED's preliminary review of workers' exposure while impregnating dry bulk fertilizer with liquid formulations of atrazine expressed concern over an absence of data and the potential for significant exposure. According to the atrazine labels, the amount of fertilizer applied per acre to corn and sorghum ranges from 200 to 700 pounds. The maximum application rate for atrazine is 2 pounds active ingredient per acre. According to information provided to the Agency, in commercial settings the herbicide is metered from a mini-bulk tank (several hundred gallons) to a mixing drum via a closed mechanical transfer system. The herbicide is sprayed onto the fertilizer, which is stirred by an auger that lifts it to the top of the drum. Up to 120 tons of fertilizer can be processed per hour. If The Agency assumes the tower functions for 8 hours per day, then 960 tons of fertilizer could be processed per 8-hour day. Information provided to The Agency indicates that typically 400 pounds of fertilizer is applied per acre to corn and sorghum.

- If two pounds atrazine active ingredient per acre is impregnated onto 200 pounds of fertilizer (for the 200 pounds fertilizer per acre rate), each ton (2000 pounds) of fertilizer would require 20 pounds of atrazine active ingredient. Thus, the total amount of active ingredient for 960 tons for the two pound active ingredient per 200 pounds of fertilizer per acre rate is (960)(20) = 19200 pounds of atrazine active ingredient handled per day.

- If two pounds atrazine active ingredient per acre is impregnated onto 400 pounds of fertilizer (for the 400 pounds fertilizer per acre rate), each ton (2000 pounds) of fertilizer would require 10 pounds of atrazine active ingredient. Thus, the total amount of active ingredient for 960 tons for the two pound active ingredient per 400 pounds of fertilizer per acre rate is (960)(10) = 9600 pounds of atrazine active ingredient handled per day.

- If two pounds atrazine active ingredient per acre is impregnated onto 700 pounds of fertilizer (for the 700 pounds fertilizer per acre rate), each ton (2000 pounds) of fertilizer would require 5.8 pounds of atrazine active ingredient. Thus, the total amount of active ingredient for 960 tons for the two pound active ingredient per 700 pounds of fertilizer per acre rate is (960)(5.8) = 5568 pounds of atrazine active ingredient handled per day.

According to information provided to The Agency, after impregnation, the treated fertilizer is gravity-fed through a hopper onto a conveyor belt leading to an auger truck, which carries it to the field. At the field, the auger truck feeds the treated fertilizer onto the applicator vehicle, which dispenses it from either a rotary spinner or a boom with numerous outlets. The transfer of the treated fertilizer in each instance is nearly dust-free, as it has been moistened by the herbicide. Based on this information, The

Agency estimated exposure to commercial handlers engaged in impregnating atrazine onto dry bulk fertilizer using dermal and inhalation unit exposure data from the PHED scenario for mixing/loading liquids using a closed system. However, such an exposure surrogate is less appropriate for transferring the treated dry bulk fertilizer from the auger truck to the application equipment. *There is no data or reasonable surrogate available for this operation.*

The Agency made assumptions in performing this assessment and acknowledges that many of the assumptions were deliberately intended toward performing an upper-end assessment. One of the most conservative of these assumptions was that the mixing tower would run at full capacity for 8 hours a day. The impregnated fertilizer market is likely to be a custom operation, in that (1) the blending occurs on an as needed/as ordered basis, and (2) only the amount ordered is prepared. It is estimated that 960 tons of atrazine-impregnated fertilizer could be produced in an 8-hour day. At 200 lbs per acre, this corresponds to 9600 acres to be treated in a day. It is assumed that a single applicator could apply to 500 acres per day at this rate. At 400 lbs per acre, this corresponds to 4800 acres to be treated per day. It is assumed that a single applicator could apply to 250 acres per day at this rate. At 700 pounds per acre, this corresponds to 2743 acres to be treated per day. It is assumed that a single applicator could apply up to 143 acres per day at this rate. Obviously, it would take several applicators to apply 960 tons of fertilizer per day.

HED also has concerns that the data in PHED may not adequately represent this scenario. This is not a typical usage under usual agricultural field conditions. The amount of atrazine necessary to impregnate the tons of fertilizer that can be processed in a day is far too large to be handled by opening individual bottles or containers (as data collected for PHED), and probably involves transfer from huge containers such as tanker trucks or railroad tank cars.

It is recognized that extrapolating a unit exposure in the range of lb ai/day from the available data in PHED is likely to result in an over-estimate. HED does not have any bulk transfer/loading data. This type of exposure data may be necessary for refining this assessment, and a possible option for Syngenta would be to supply data per guideline numbers 875.2400 (dermal exposure) and 875.2500 (inhalation exposure) for mixer/loaders.

Handler Exposure and Risk Estimates

Durations of exposure are anticipated to be short-term (1-30 days) and intermediate-term (one to several months) for occupational assessments and short-term only for residential handler assessments. Data submitted by the registrants suggest most agricultural workers handle atrazine (mix, load or apply) less than 30 days per year, although the exact percentage of the worker population is unknown.

The short-term endpoints for dermal and inhalation exposures to atrazine, although based on separate studies, have a common endpoint effect and therefore can be aggregated. The intermediate-term dermal and inhalation endpoints have the same adverse effect and therefore, the intermediate-term risks are aggregated. Each endpoint was chosen because it was the lowest-dose effect for that route and duration of exposure. Where a developmental endpoint was chosen, the mean female body weight (60 kg) is

applicable, and exposure risk estimates are considered protective of the entire (both genders) working population. A correction factor for difference in body surface area between males and females is being developed; until then the risk estimates based on the developmental endpoint are considered slightly more conservative (overestimated) for males.

Handler exposure assessments are completed using a baseline exposure scenario and, if required, increasing levels of risk mitigation (PPE and engineering controls) to achieve an appropriate margin of exposure. Tables 5-7 present exposure and risk assessment calculations for the handling of atrazine. The daily exposures are used to complete the dermal and inhalation risk assessments for short and intermediate-term exposure scenarios. The baseline scenario generally represents a handler wearing long pants, a long-sleeved shirt, and no chemical-resistant gloves. Table 5 presents the dermal and inhalation exposures to atrazine at baseline. Table 6 presents the exposure/risk calculations with PPE mitigation, and Table 7 presents the exposure/risk calculations when handlers employ engineering controls mitigation.

Potential daily exposures were calculated using the following formulae:

$$\text{Daily Dermal Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) = \text{Unit Exposure}\left(\frac{\text{mg ai}}{\text{lb ai}}\right) \times \text{Use Rate}\left(\frac{\text{lb ai}}{A}\right) \times \text{Daily Acres Treated}\left(\frac{A}{\text{day}}\right)$$

$$\text{Daily Inhalation Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) =$$
$$\text{Unit Exposure}\left(\frac{\mu\text{g ai}}{\text{lb ai}}\right) \times \text{Conversion Factor}\left(\frac{1\text{mg}}{1{,}000\ \mu\text{g}}\right) \times \text{Use Rate}\left(\frac{\text{lb ai}}{A}\right) \times \text{Daily Acres Treated}\left(\frac{A}{\text{day}}\right)$$

Inhalation and dermal doses were calculated using the following formulae:

$$\text{Daily Inhalation Dose}\left(\frac{\text{mg ai}}{\text{kg/day}}\right) = \text{Daily Inhalation Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) \times \left(\frac{\text{Inhalation Absorption Factor}\left(\frac{\text{percent}}{100}\right)}{\text{body weight (kg)}}\right)$$

where: inhalation absorption factor is assumed to be 100 percent for both short- and intermediate term doses

$$\text{Daily Dermal Dose}\left(\frac{\text{mg ai}}{\text{kg/day}}\right) = \text{Daily Dermal Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) \times \left(\frac{\text{Dermal Absorption Factor}\left(\frac{\text{percent}}{100}\right)}{\text{body weight (kg)}}\right)$$

where: dermal absorption is assumed to be 6 percent or 0.06 for the intermediate-term assessment and 100 percent for the short-term assessment

The dermal absorption factor of six percent was applied to the intermediate term exposure estimates. The short term exposure assessment does not require use of a dermal absorption factor since

the toxicity endpoint is based on a 21 day dermal study. The short-term dermal dose was calculated using a 70 kg body weight. The short-term inhalation doses were calculated using a 60-kg body weight. Both inhalation and dermal intermediate-term doses were calculated assuming a body weight of 60 kg since the toxicity endpoints are based on a 6-month luteinizing hormone study.

The following formulae were used in the calculation of the short- and intermediate-term dermal and inhalation MOEs.

$$\text{Dermal MOE} = \frac{\text{Dermal NOAEL (mg/kg/day)}}{\text{Short- term Dermal Dose (mg/kg/day)}}$$

$$\text{Inhalation MOE} = \frac{\text{Inhalation NOAEL (mg/kg/day)}}{\text{Short- term Inhalation Dose (mg/kg/day)}}$$

Since both the short-term dermal and inhalation endpoints include the effect of decreased weight gain, the short-term doses were aggregated. The dermal and inhalation intermediate-term endpoints were based on a 6-month LH study therefore doses were aggregated across routes. Aggregate MOEs for short and intermediate-term exposures were calculated using the following formula:

$$\text{Aggregate MOE} = \frac{1}{\frac{1}{\text{dermal MOE}} + \frac{1}{\text{inhalation MOE}}}$$

Handler Exposure and Cancer Risk Estimates

Not applicable as atrazine was classified by the CARC report of December 13, 2000, as "Not Likely to be Carcinogenic to Humans."

Summary of Risk Concerns for Handlers, Data Gaps, and Confidence in Exposure and Risk Estimates

Short-term Exposure Duration

The baseline short- and intermediate-term handler exposure and risk estimates are shown in Table 5. The total number of scenarios assessed was 139, but, depending on data available or controls available, not all scenarios could be assessed for each level of exposure control. The six scenarios for label uses of liquid formulation on liquid fertilizer had no data at any level of control, while the six liquid formulation on dry fertilizer scenarios were assessed for closed systems only. For the aerial applicators, data were available for the 13 engineering control (closed cockpit) scenarios only. Therefore, with baseline, or single-

layer clothing, and bare hands, two-thirds (76 of 111; 28 no baseline data) of the exposure scenarios assessed had dermal MOEs greater than 100; all of the inhalation MOEs exceeded 100, resulting in 79 scenarios with aggregate MOEs greater than 100. By adding gloves, 113 of 114 applicable scenarios had an aggregate MOE of 100 or greater and the remaining scenario's MOE was 97 (See Table 6). Engineering exposure control methods were only required to mitigate one scenario, but, where applicable, would result in all dermal, inhalation, and aggregate MOEs exceeding 100 (see Table 7). The PHED and corn applicator study data (which used closed systems) were combined as in the registrant submission and had essentially the same outcome as the PHED data alone for the engineering control scenarios (see Table 8). All but one handler scenario (six were fertilizer scenarios lacking sufficient data to assess) had short-term aggregate MOEs greater than 100.

The combined passive dosimetry/biomonitoring study (MRID 441521-09/11) data were used to calculate agricultural handler MOEs using mean and 90th percentile values (Table 4). In order to compare the estimated daily exposures to those calculated using PHED data, the dermal dose from passive dosimetry and the calculated internal dose from biomonitoring were adjusted for daily lbs ai handled using the same label application rate and estimated daily acres treated (2 lbs ai/acre and 200 acres/day). The 90th percentile biomonitoring values provided short-term estimated MOEs of 100-400 for the different job categories involved in mixing, loading, and applying liquid formulation by groundboom. The passive dosimetry 90th percentile data for the same handler exposure scenarios produced MOEs ranging from 130 to 390.

The biomonitoring-only study (MRID 441521-05/06) included various formulations, levels of protection (mostly closed mixing/loading and enclosed cab), quantities handled, and application rates. The study did not control for prior day's exposure to atrazine. Because approximately 12% of atrazine is excreted as chlorometabolites in the 24 hours after exposure, with repeated daily exposure it is difficult to determine the relation between amount of chemical handled and dose excreted. Therefore no attempt was made to normalize the exposure by amount of atrazine handled. Using the 90th percentile of the data, normalized to body weight only, short-term daily MOEs greater than 100 (range 740-2600) were estimated for all mixers, loaders, applicators, and mixer/loader/applicators applying ground spray to corn.

For quality assurance purposes, the 90th percentile atrazine mean daily dose excreted in urine for each work task (mixer/loader, applicator, mixer/loader/applicator) from both of the submitted biomonitoring studies were compared (see Table 4). This daily dose was used to determine a MOE. The MOEs from each study were compared. The finding was that the biomonitoring doses, and MOEs were very similar for each task category when the mean maximum 90th percentile were compared; less than a four-fold range existed between studies (ST MOE range 460-2600; IT MOE range 83-470) . The total dose was assumed to be 99% from the dermal route and only 1% inhalation based on atrazine-specific and PHED data for each task.

Intermediate-term Exposure Duration

As stated previously in this document, intermediate-term exposures of a month or more are considered less common than short-term exposures for atrazine handlers, but are presented for the purpose of identifying potential risks and may be further refined as more atrazine-specific use data becomes available. All baseline clothing intermediate-term LCO handler scenarios had MOEs greater than 100 using the ORETF study data. Only about a third (41/111; 28 no baseline data) of agricultural baseline clothing handler scenarios using PHED data had combined dermal and inhalation intermediate-term MOEs equal to 100. Baseline dermal risk estimates were generally greater than inhalation, with 38% of dermal and 85% of inhalation MOEs equal to or greater than 100. Addition of gloves alone raised the proportion of aggregate MOEs greater than 100 to one-half. Even with gloves, coveralls, and a respirator added, only two-thirds (76 of 114; 25 no data) scenarios had aggregated dermal and inhalation MOEs equal to 99 (several more had MOEs greater than 95). Dermal MOEs were much lower than inhalation MOEs with protective equipment (all inhalation MOEs were above 100 with respirators). Engineering exposure controls provided 108 of 139 (78%) of handlers with combined dermal and inhalation MOEs greater than 100. There were no data for liquid/liquid fertilizer treatment and the right-of-way and hand sprays had no known engineering controls. Using the corn applicator study with engineering controls (Table 8), only the high-acreage mixing/loading scenarios and the commercial fertilizer mixing scenarios had aggregate MOEs less than 100.

Handler Scenarios with Risk Concerns

Short-term Exposure Duration

Most handler exposure scenarios estimated using PHED had MOEs greater than 100 when personal protective equipment or engineering controls were used (see Summary Table 9). The most common scenarios, in terms of pounds of active ingredient used annually, are the aerial and ground spraying of corn and sorghum. Almost all of the short-term exposure scenarios which had MOEs less than 100 with baseline clothing were mixing and loading liquid formulations in open systems (for aerial, groundboom, LCO or fertilizer admixture). There are also large uncertainties in the estimates of materials handled in fertilizer treatment and the amount of fertilizer applied per day. All methods of application (granular, spray) to lawns by LCOs, using ORETF data, had short-term MOEs greater than 100 at baseline. The PHED data was incomplete for the baseline LCO scenarios.

Summary of PHED Short-term Risk Estimates:

Baseline:

- Short-term inhalation at baseline MOE > 100 for all scenarios
- Short-term dermal risks at baseline are:
    - MOE < 100 for mixing/loading liquids for most equipment
    - MOE > 100 for mixing/loading dry flowable for all equipment
    - MOE > 100 for loading granulars
    - MOE > 100 for all applicator scenarios for which data are available
    - MOE < 100 for mixer/loader/applicator scenarios involving spray applications for which data are available

- MOE > 100 for all flagger scenarios

PPE:

- All short-term aggregate risks are not of concern either at baseline or with PPE for all applicable scenarios,
- All mixer/loaders scenarios involving liquid formulations are not of concern with gloves. (Note: some are already not of concern at baseline and aerial or dry bulk fertilizer require engineering controls).
- Mixer/loader/applicators scenarios involving sprays are not of concern with baseline attire plus gloves.
- All loader scenarios involving granular formulations, all applicators (except where no data are available -- such as aerial applications), all loader/applicators involving granulars formulations, and all flaggers supporting aerial spray applications are not of concern at baseline attire -- without additional PPE

Intermediate-term Exposure Duration

As with short-term scenarios, most of the baseline intermediate-term dermal risk estimates which had MOEs less than 100 were for mixer-loaders, of liquids, dry flowable/water dispersible granules, and also mixing pesticide into fertilizers. Right-of-way sprayers, turf applicators, and one flagger also had dermal MOEs below 100. The flagger scenario was for the highest rate, 4 lbs ai/acre at 350 acres per day. As stated above, 85% of inhalation exposure risk estimates had MOEs greater than 100 without a respirator, with mixer/loaders accounting for most of the higher risk estimates. Even with coveralls, gloves, and respirators, most of the mixer/loader dermal risk estimates for the larger crops, including corn and sorghum, remain above the level of concern. Only one of the intermediate-term aggregate applicator risk estimates was below a MOE of 100 with maximum protective clothing: the right-of-way sprayer using the 4 lb ai/acre rate. Engineering controls raise most of the aggregate MOEs above 100, except for mixing and loading of the largest quantities (liquid or dry flowable/WDG) of chemical handled, such as for the higher rates on chemical fallow lands, grasslands, corn, sorghum, and fertilizer. With engineering controls, all applicator risk estimates have MOEs above 100, except the highest aerial application rate for chemical fallow land (MOE 82). While intermediate-term exposures for LCOs using PHED all required gloves and/or coveralls to achieve MOEs above 100, the baseline intermediate MOEs were all above 100 when ORETF data was used (Table 10). The geometric mean values of the passive dosimetry sampling from study MRID 441521-09/11 were used to estimate a central-tendency intermediate-term dose. The estimated mixer/loader, mixer/loader/applicator and applicator MOEs (with engineering controls for most replicates) ranged from 210-520. Intermediate-term MOEs based on the geometric mean biomonitoring data from the same study for all handlers were between 69-470 when normalized by lb ai handled, and MOEs of 330-960 were estimated by daily dose alone. The geometric mean data from the MRID 445976-05/06 study were normalized to body weight and daily MOEs of 430-1600 were estimated.

Summary of Intermediate-term aggregate dermal and inhalation risks:

Baseline

- MOE < 100 for all mixer/loader scenarios for liquid formulations
- MOE < 100 for all mixer/loader scenarios for dry flowable formulations, *except*
  --groundboom applications to sugarcane at 2.6 lb AI per acre and 80 acres per day (MOE=110); to roadsides at 1.0 lb AI per acre and 40 acres per day; Bermudagrass rights-of-way at 4.0 lb AI per acre and 40 acres per day; to golf course turfgrass at 2.0 lb AI per acre and 40 acres per day; and to sod farms at 2.0 lb AI per acre and 80 acres per day; and
  -- rights-of-way applications
- MOE > 100 for loading granulars
- MOE > 100 for applying with groundboom equipment, except when the rate is 2 lb or greater AI per acre and 450 acres per day are treated
- MOE < 100 for applying with a rights-of-way sprayer
- MOE > 100 for applying impregnated dry fertilizer, except at the 2 lb AI rate and applying to 500 acres per day
- MOE > 100 for applying granular with ground equipment
- MOE < 100 for all mixer/loader/applicator scenarios applying liquids for which data were available
- MOE > 100 for mixers/loader/applicator scenarios applying granulars with push-type spreader
- MOE < 100 for mixers/loader/applicator scenarios applying granulars with bellygrinder
- MOE < 100 for flagging except with an application rate of 4.0 lb AI and applying to 350 acres per day

PPE intermediate-term aggregate (dermal plus inhalation) risks

- Mixer/loader scenarios involving support of aerial applications with liquid formulations are of concern, even with baseline attire plus maximum PPE at the higher application rates (i.e., 2.6 pounds active ingredient per acre and above).
- Other mixer/loader scenarios involving support of aerial applications with liquid formulations are not of concern with baseline attire plus PPE (ranging from gloves to gloves plus double layers to gloves plus double layers plus respirator) at rates of 2.0 pounds active ingredient per acre and below *provided* the acres treated per day are 350 per day or less. When 1200 acres are treated per day, the risks are of concern at all application rates.
- Mixer/loader scenarios involving support of groundboom, rights-of-way, and lawn handgun applications and on-farm incorporating liquid formulations into dry bulk fertilizer are all not of concern with baseline attire plus PPE (ranging from gloves to gloves plus double layers), *except* scenarios involving application rates of 2.0 pounds or more active ingredient per acre and 450 or more acres treated per day, which are of concern even with maximum PPE of gloves plus double layers plus respirator.

- Mixer/loader scenarios involving support of aerial applications with water dispersible granule formulations are of concern even with maximum PPE at all application rates.
- Mixer/loader scenarios involving support of groundboom and rights-of-way applications are not of concern either with baseline attire or baseline attire plus PPE (ranging from gloves to gloves plus double layers), *except* scenarios involving 300 or more pounds of active ingredient handled per day, which are of concern even with maximum PPE of gloves plus double layers plus respirator.
- All applicator and mixer/loader/applicator scenarios (for which data are available) are not of concern either with baseline attire or baseline attire plus PPE (ranging from gloves to gloves plus double layers to gloves plus respirator), *except* for applying with a rights-of-way sprayer, which is of concern even with maximum PPE. Note that engineering controls are not available for this scenario.
- All flagger scenarios are not of concern with baseline attire or with baseline attire plus PPE (ranging from double layers to double layers plus respirator), *except* for flaggers supporting applications of 4 pounds active ingredient per acre to 350 acres per day (high-end).

Summary of Engineering Control Risk Estimates

- All mixer/loader scenarios involving liquid formulations are not of concern with baseline attire, baseline attire plus PPE, or engineering controls, *except* scenarios involving support of aerial applications of 2.0 or more pounds active ingredient per acre to 1200 acres per day and impregnating dry bulk fertilizer in commercial establishments at all application rates and estimated amounts handled per day.
- All mixer/loader scenarios involving water dispersible granular formulations are not of concern with baseline attire, baseline attire plus PPE, or engineering controls, *except* scenarios involving support of aerial applications of 4.0 pounds active ingredient per acre to 350 acres per day; and support of aerial applications of 1.4, 2.0, or 3.0 pounds active ingredient per acre to 1200 acres per day.
- All aerial application scenarios are not of concern with enclosed cockpits, *except* applications of 3.0 or 4.0 pounds active ingredient per acre to 1200 acres per day.
- All other applicator scenarios are not of concern with baseline attire or baseline attire plus PPE, *except* (as noted above under PPE) for applying with a rights-of-way sprayer and mixing/loading/applying with a backpack/knapsack sprayer, which are of concern even with maximum PPE. Note that engineering controls are not available for these two scenarios.
- All flagger scenarios are not of concern with baseline attire, baseline attire plus PPE, or engineering controls.

Data Gaps

Data gaps exist for the following scenarios:

- No PHED unit exposure values exist for combining herbicides with fluid fertilizer; mixing liquid formulations was used as a surrogate.

- PHED unit exposure values are not available for using liquid formulations to impregnate dry bulk fertilizer; therefore, closed system engineering control values for mixing and loading liquids were used as a surrogate for commercial operations. There were insufficient data to be used as a surrogate for on-farm operations.

- No exposure data were available for application of treated fertilizer to soil.

- More information on days of use per year for agricultural applicators would help refine the risk assessment by selection of the most appropriate endpoint.

Data Quality and Confidence in Assessment

Several issues must be considered when interpreting the occupational exposure risk assessment. These include:

- The most common use scenarios, agricultural field spraying, had chemical specific data submitted to support the unit exposures used. Newly submitted data from the ORETF (not chemical-specific) with higher confidence level than the PHED data sets, was used for some turf applications. However, several handler assessments (including aerial and belly-grinder) were completed using "low quality" PHED data due to the lack of a more acceptable data set.

- Regarding the dry bulk fertilizer scenarios, additional information from the registrant may be necessary to fully understand the range of operating conditions for mixer/loaders, such as number of tons or gallons treated in a day, application rates used, tons of impregnated fertilizer applied per acre and number of day worked impregnating fertilizer and any other task that may be required such as loading the impregnated fertilizer into trucks for transport to the fields.

- Biomonitoring data were of low confidence due to a lack of creatinine measurements and/or incomplete collection; lack of a baseline excretion measure; and none were sampled for 72 hours after a single exposure to obtain most of the chlorometabolites.

POSTAPPLICATION EXPOSURES AND RISK ESTIMATES

Postapplication Exposure Scenarios

Most of the atrazine used in agriculture is applied to corn and sorghum early in the season, either before weeds emerge (pre-emergence) or when the crops are quite small (generally less than 12 inches high). This fact, and the degree of mechanization in cultivating these crops, minimizes the postapplication contact of workers with the chemical on these crops. However, the Agency has determined that there are potential postapplication exposures to individuals re-entering atrazine treated areas for the purpose of:

- *Corn and sorghum*: irrigating and scouting
- *Macadamia nut orchards*: mowing and scouting
- *Guava orchards*: mowing and scouting
- *Sugarcane fields*: scouting
- *Conifer (including Christmas tree) farms*: scouting, **pruning, staking, harvesting**
- *Sod farms*: mowing, scouting, and **harvesting**
- *Golf-course turfgrass*: mowing and scouting

Some data received during the initial comment period have been used to refine and characterize the potential postapplication exposures to atrazine (bold lettering above). According to use information submitted by Syngenta and verified by BEAD and HED agricultural experts, no regular reentry activities occur in conifer forests during the seedling stage, when atrazine is used, other than fertilizing. Atrazine is applied in the "dormant" months to conifer tree farms, and staking and shaping are not done at that time. No hand weeding is anticipated on sod farms, and it is not common on golf courses. Harvesting sod is a high-exposure activity, but would not occur within the 30 day pre-harvest interval in Florida, and is considered "unlikely" to occur within 30 days of an application in other states, for economical reasons alone. Additional data on sugarcane postapplication activities are needed, but atrazine is not applied once the crop has "closed in."

Data Sources for Scenarios Considered

Three chemical-specific studies, one of dislodgeable foliar residue on corn, and two of transferable turf residues, were submitted in support of the reregistration of atrazine. All three studies were reviewed and found to acceptable for use in the atrazine risk assessment.

MRID 448836-01. *Dissipation of Dislodgeable Foliar Residues of Atrazine on Field Corn. Prochaska, L.M. (1999). Stewart Agricultural Research Project Number: SARS-97-54; Wildlife International Project Number: 468C-105. Unpublished study prepared by Stewart Agricultural Research Services. 131 pages.*

This dislodgeable foliar residue (DFR) study was submitted by Sipcam Agro USA, Inc. (formerly Sostram Corporation), in support of atrazine re-registration requirements. The study was conducted at one test plot located in Shelby County, Missouri. Atrazine was applied once to field corn in two different formulations, Atrazine 4L and Atrazine 90DF. Atrazine 4L is a liquid suspension concentrate containing 4.0 lbs ai/gallon and Atrazine 90DF is a water dispersible

granules containing 90 percent active ingredient. The formulations were applied using CO_2-pressurized backpack sprayers equipped with flat fan nozzles. Application volume was 20 gallons per acre. Atrazine 4L was applied at a rate of 2 lbs ai/A and Atrazine 90DF was applied at a rate of 2.5 lbs ai/A. Labels indicate that the maximum application rate was 2.5 lbs ai/A per calendar year and the minimum spray volume was 10 gallons per acre. Corn was 12 inches high when the study began. Samples were collected at 4 hours, 12 hours, 1 day, 2 days, 3 days, 5 days and 7 days after application.

Concurrent fortified laboratory recovery samples and two sets of field-fortified samples showed good recoveries and indicated that there was no appreciable loss of atrazine during shipping and sample storage. The study met most criteria identified in OPPTS Test Guideline Series 875.2100, Foliar Dislodgeable Residue Dissipation: Agricultural. Significant deviations from this guideline were:

- The study was conducted at only one location, instead of at three locations as specified in the guideline.
- The target application rate for both formulations was 2.5 lb ai/A, which was the maximum annual application rate. However, the Atrazine 4L formulation was applied at 2.0 lb ai/A due to a calculation error.
- The spray volume was twice the minimum application volume specified on product labels. Under the guidelines, application should be made using the least dilution and highest label permitted rate.
- Although samples of the spray solution were collected at the time of application, these samples were not analyzed by the analytical laboratory. It could not be determined if the target application rate was attained.

The highest mean atrazine residues occurred at 4 hours after application for both the Atrazine 90DF (4.21 µg/cm^2) and Atrazine 4L (2.64 µg/cm^2) formulations. Other residue values are shown in Table 11.

The uncorrected dislodgeable foliar residue data from Day 0 through Day 7 data were averaged, natural log (ln) transformed and analyzed assuming first-order dissipation kinetics using simple linear regression. Calculated atrazine dissipation half-lives were 1.56 days (R^2=0.95) for Atrazine 4L and 1.2 days (R^2=0.87) for Atrazine 90DF.

MRID 449580-01. *Determination of Transferable Residues on Turf Treated with Atrazine.* Hofen, J. (1999). Stewart Project Number: SARS-98-81. Ricerca Project Number: 7617-98-0197-CR Unpublished study prepared by Stewart Agricultural Research Services, Inc. and Ricerca, Inc. 358 pages.

This study on turf-transferable residues (TTR) was submitted by Sipcam Agro USA, Inc. in support of atrazine reregistration requirements. The dry-flowable formulation (Atrazine® 90DF) was applied to Bermuda grass turf in Georgia (using a backpack sprayer) and North Carolina (using a tractor mounted sprayer). The study quantified turf-transferrable atrazine residues collected on cloth sheeting.

Overall, the study met most guideline criteria of the Environmental Protection Agency*s (US-EPA) OPPTS Series 875.2100, Transferable Residue Dissipation: Lawn and Turf. The most important deviations were:

- Only two geographically distinct test sites were included in this study.
- Only one application was made in this study while the label permits a second application to turf.
- No tank mix samples were collected and analyzed.

Atrazine® 90DF was applied once at an application rate of 0.72 ounces active ingredient (ai) per 1,000 square feet (±5%). This rate was 90 percent of the maximum label rate. Table 11 shows the measured atrazine levels for the Georgia and North Carolina study sites. Pre-trial residues at both sites were all less than the detection level of 0.00090 :g/cm^2. Levels remained below the detection levels at the control plots for both sites throughout the study. Turf-transferable atrazine levels did not dissipate rapidly. At both test sites, atrazine transferable residues increased up to 12 hours after application and then decreased from 12 hours after application through 21days after treatment. In North Carolina, the average day-of-application transferable residue was 1.32 :g/cm^2, decreased by ten-fold in the first 24 hours, increased slightly during the first week, then declined slowly thereafter. In Georgia, the average residue level was 0.24 :g/cm^2 after application and declined to 0.14 :g/cm^2 on day 21. This value was substantially higher than the value of 0.030 :g/cm^2 attained at day 14. No explanation for this increase at the Georgia study site was offered. This finding was not reported in

North Carolina. Both laboratory recoveries and field fortifications were satisfactory, although the field fortifications were run at levels which were outside the range of the TTR samples.

Natural log (ln) transformed data were analyzed using linear regression assuming pseudo-first order dissipation kinetics. Turf-transferable residue data were not corrected for field or laboratory recovery. Because the first regression analysis of all data yielded low correlation coefficients at both study sites, an additional analysis was performed omitting day 3 and day 21 residue data from Georgia and 12 hour residue data from North Carolina. The calculated atrazine half-lives for the first regression (all data)were 17.1 days for Georgia (R^2=0.18) and 3.2 days for North Carolina (R^2=0.81). For the second regression, the calculated atrazine half-lives for Georgia and North Carolina were 5.2 days (R^2=0.89) and 3.8 days (R^2=0.88), respectively.

MRID 449588-01. *Determination of Transferable Turf Residues on Turf Treated with Atrazine Applied in a Granular Fertilizer Formulation.* Rosenheck, L. (1999). Novartis Laboratory Number 805-98. ABC Laboratory Number 45035. Unpublished Study prepared by Novartis. 183 pages.

This study on turf-transferable residues (TTR) was submitted by Novartis Crop Protection, Inc. in response to an occupational/residential exposure Data Call-In, and in support of atrazine re-registration requirements. Scott's Bonus S Weed and Feed®, a granular fertilizer product containing 1.099 percent atrazine, was applied to turf in Georgia and Florida, and the effect of subsequent irrigation on residue levels was examined. The study quantified turf-transferrable atrazine residues collected on cloth sheeting. Scott's Bonus S Weed and Feed® was applied once to irrigated and non-irrigated tur test-plots in Georgia and Florida at a target application rate of 2.0 lbs active ingredient per acre. Turf-transferable atrazine residue samples were collected at intervals up to 35 days after treatment.

Overall, the study met most criteria of the OPPTS Post-application Exposure Monitoring Test Guidelines, 875.2100, Transferable Residue Dissipation: Lawn and Turf. The most significant deviations were:

- Only two distinct test sites were included in this study, rather than the three required by the guidelines.
- Only one application was made in this study although the product label permits a second application to turf.
- No control test-plots were designated, therefore no control samples were collected. Pre-application "control" samples were mostly negative for atrazine, except for four collected from the watered-in test plot in Florida. These levels were just at, or above, the Minimum Quantifiable Limit (MQL) of 5 µg/sample.

The highest average turf-transferable residue (0.2160 ∶g per cm ^{2}) occurred in the Florida non-irrigated test plot at 4 hours. On Day 1, the average turf-transferable residues were 0.0077 ∶g per cm ^{2} (irrigated) and 0.0883 ∶g per cm ^{2} (non-irrigated) at the Florida test site and 0.0097 ∶g per cm ^{2} (irrigated) and 0.0351 ∶g per cm ^{2} (non-irrigated) at the Georgia test site. See Table 11.

The turf transferrable atrazine residue data were corrected using an average field-fortified recovery value of 89.9 percent (an average value from field fortified sample results for two fortification levels at both test sites). The corrected data from day 0 to day 35 were averaged, natural log (ln) transformed, analyzed using simple linear regression assuming pseudo-first order dissipation kinetics. Calculated dissipation half-lives for Georgia were 6.9 days (R^2=0.91) and 8.9 days (R^2=0.46) for non-irrigated and irrigated test-plots, respectively. The calculated dissipation half-lives for Florida were 4.9 days (R^2=0.93) and 3.3 days (R^2=0.71), for non-irrigated and irrigated test-plots, respectively.

Assumptions Used in Postapplication Exposure Calculations

Based on data submitted for reregistration, and the Quantitative Usage Analysis (6/99) by D. Widawsky of the Biological and Economic Assessment Division, the most common postapplication exposures will occur for workers in field crops, primarily corn and sorghum, and on turf. Based on label

restrictions and pattern of use, atrazine is only applied in the early part of the corn or sorghum growth cycle, when the plants are less than 12" tall. The only activities at this time would be scouting or irrigating, which have low contact potentials (transfer coefficients). Chemical-specific data is available for DFRs on corn, which can also be used as a surrogate for sorghum. Scouting and irrigating are the only common early season practices for sorghum as well, and this crop is mechanically harvested. The foliar residue data from corn are not considered appropriate to translate to conifers, owing to the great difference in leaf structure, shape, and overall plant conformation. Due a lack of other DFR data, however, the corn residues will be used for screening-level risk assessments. Sugar cane crops are burned, then harvested mechanically, then sprayed with atrazine. Based on sugar cane cultural practice, workers will not normally enter treated fields on foot until planting, which is months after atrazine application. Nut and guava orchards are typically sprayed by ground equipment in such a manner as to limit the amount of foliage on the tree that is sprayed, although aerial application is also possible. There should be minimal postapplication exposure to workers in those types of orchards when ground methods are used. Mowing would be a common postapplication activity after either spraying method. Treated turf or grasses will routinely require reentry activities, such as mowing and watering, and eventually harvesting in the case of sod farms. Fallow, right-of-way, and prairie might also be mowed. Therefore the studies listed above that are chemical-specific for atrazine, and the DFRs may be used in estimating postapplication exposures.

Because atrazine has a low vapor pressure (3.0×10^{-7}) and is only used outdoors, and based on a large historical database, the inhalation component of postapplication exposure is anticipated to be negligible. Therefore, all calculations of postapplication risk estimates have been done for dermal exposure only, and there was no need to aggregate postapplication exposure routes for workers.

Many of the atrazine uses are for pre-emergent uses. Since atrazine is used on crops which are predominantly planted and harvested mechanically, there would usually be little postapplication exposure due to pre-emergent uses. The MOEs provided in this assessment are only for the foliar applications.

The applicability of postapplication risk assessments to working farm children (ages 12 and over) has been evaluated by the Agency. Historical transfer coefficient data indicate that the higher the productivity of a worker the higher the transfer coefficient. HED believes that it is reasonable to assume that the productivity of a 12 year old is less than that of an adult. HED believes that transfer coefficients for 12 year olds are lower than for adults and that the difference in the magnitude of the transfer coefficient will nullify the 18 percent underestimate attributed to the ratio of body surface area to body weight (internal communication, J. Dawson, EPA, 12/2000).

Exposure and Risk Calculations

Short- and intermediate-term daily absorbed doses and MOEs were calculated as follows:

$$\text{Dose (mg/kg/d)} = \frac{(\text{DFR } (\mu g/cm^2) \times Tc\ (cm^2/hr) \times CF\left(\frac{1\ mg}{1{,}000\ \mu g}\right) \times Abs \times ED\ (hrs/day))}{BW}$$

Where:

DFR	=	daily DFR, as calculated above for the assumed average reentry day
Tc	=	transfer coefficient;
CF	=	conversion factor (i.e., 1 mg/1,000 µg)
Abs	=	dermal absorption (100 percent for short-term, and 6 percent for intermediate-term)
ED	=	exposure duration; 8 hours worked per day
BW	=	body weight (70 kg for short-term and 60 kg for intermediate-term)

Dermal MOEs were calculated as follows:

$$MOE = \frac{NOAEL\ (mg/kg/day)}{Dose\ (mg/kg/day)}$$

Where:

NOAEL	=	360 mg/kg/day for short-term and 1.8 mg/kg/day for intermediate-term
Dose	=	calculated absorbed dermal dose

For the purposes of occupational risk assessments, the following residue values were chosen:

- Although the short-term endpoint is defined as adequate for activities lasting up to one month, some activities may have more than 30 days exposure. It is considered unlikely that a postapplication worker reentering treated fields or turf for more than 30 days would have a daily exposure to residues greater than those 7 DAT.

- For short-term postapplication turf activities, the average (formulation-specific) postapplication residues for each state were used with standard values for transfer coefficients (updated 8/2000). For intermediate-term activities, the average DAT 7 transferable residues were used.

- For post-application activities on crops other than turf or grasses, the highest average daily residues from the corn DFR study were used for the short-term, and the average DAT 7 residues were used for the intermediate term risk estimates. Standard transfer coefficients were used.

Postapplication Exposure Risk Estimates

The various potential postapplication worker exposure scenarios cited above can be bracketed using the results of the corn DFR study for reentry into corn or sorghum, and using the turf DFR studies for turf and sod reentry activities. As noted above, these are representative exposures, and it is considered unlikely that higher exposures than those calculated for these crops will occur. The corn DFR data were applied to other crops, such as sugar cane and tree farms, for screening purposes, but the resulting MOEs are considered highly conservative based on the entry practices cited in the previous section.

The ARTF transfer coefficients were applied wherever possible. The reentry MOEs for corn and sorghum ranged from 2300 for short-term to 22,000 for intermediate-term risk estimates (see Table 12). Scouting activities in sugarcane had an estimated short-term MOE of 2000 and intermediate-term MOE of 550. High-contact activities in tree farms, although the data was not highly translatable, had MOEs of 120-470 for short-term and 140-1100 for intermediate-term exposures. Scouting conifer forests had estimated MOEs ranging form 470 to 1100 for short- to intermediate-term exposures, using the same corn DFR data. Mowing and other activities in grasslands and other fallow areas, using the highest turf DFRs, had short- to intermediate term MOEs of 1900-4400.

For turf or sod mowing and harvesting, transfer coefficients of 500 and 16,500 cm^2/hr were used, based on the ARTF study data (see HED Exposure SAC Policy guidance 3.1, 8/00). Short-term exposure from mowing treated turf had an estimated MOE of 4300-26,000, using the highest average first day-after-treatment (DAT 1) DFR data from the spray application (see **Table 13** for granular DFR data and **Table 14** for liquid DFR data and MOE calculations). Using the granular application study highest average DFR data, MOEs ranged from 5700 to 110,000 for mowing turf and sod. The lowest MOEs from spray application were 100 and 130 for GA and NC data used to predict high-contact activities such as harvesting sod. For the highest contact activities on grass, using the granular DFR data yielded MOEs of 170-1600. All other activity MOEs translated from the turf DFR data had MOEs lying between 350 and 220,000 (transplanting sod vs. mowing/scouting roadsides).

Summary of Postapplication Risk Concerns, Data Gaps, and Confidence in Exposure and Risk Estimates

Using the highest average daily foliar residues from each study at day 0-1 and day 7 after treatment, all postapplication short- and intermediate-term dermal risk estimates for all scenarios were below the HED's level of concern. The lowest MOEs, for trimming/harvesting Christmas trees (120) and harvesting sod (100), were assessed shortly after application and used transfer coefficients and residue levels which were combined to make a high-end or conservative exposure estimate.

There are no chemical-specific or suitable surrogate residue data for conifers, and therefore the postapplication worker exposure to conifers treated with atrazine cannot be assessed accurately. However, the patterns of application (aerial and ground-spray), generally target the pest species rather than the tree crop. In Christmas tree farms, there is infrequent entry into the forest, workers wear long sleeves for protection, and therefore postapplication exposure is very limited. Risk estimates are based on

chemical-specific studies which are believed to be reasonable surrogates for both corn and sorghum postapplication exposure.

NON-OCCUPATIONAL EXPOSURES AND RISK ESTIMATES

Residential Handler Exposures & Risk Estimates

The Agency has determined that residential and other non-occupational handlers are likely to be exposed during atrazine use. The anticipated use patterns and current labeling indicate 6 major exposure scenarios, based on the types of equipment that potentially can be used to make atrazine applications. The scenarios include:

(1) mixing/loading/applying liquid formulations using a backpack sprayer,
(2) mixing/loading/applying liquid formulations for application with a low pressure handwand,
(3) mixing/loading/applying liquid formulations for hose-end sprayer,
(4) loading/applying granular formulations with a push type spreader, and
(5) loading/applying granular formulations with a bellygrinder.

Residential Handler Exposure Scenarios -- Data and Assumptions

Residential handler exposure assessments were completed by HED assuming an exposure scenario for residents which includes the following attire: short sleeved shirt, short pants, shoes and socks, and no gloves or respirator. The atrazine lawn applicator exposure study contained only persons wearing long sleeves, long pants, and gloves. The original hose-end sprayer study used for PHED had only 8 replicates, all of whom wore gloves, and all hand residues were non-detectable. The recently submitted ORETF exposure study data for push type granular spreader and hose-end sprayer had greater numbers of replicates and therefore greater statistical power than studies previously used in PHED. Therefore, in the absence of atrazine-specific data, the ORETF data will be used for those two scenarios, and the remaining handler exposure estimates will use PHED data. The ORETF surrogate study for granular application was described in the Occupational Exposure Data section, and the hose-end sprayer exposure study will be described in this section. Surrogate PHED data used to estimate daily unit exposure values were taken form the *Standard Operating Procedures (SOPs) for Residential Exposure Assessments* (December 1997; revised 1999 by submission to the SAP). Table 15 summarizes the caveats and parameters specific to the surrogate data used for each scenario and corresponding exposure/risk assessment. The following assumptions and factors were used in order to complete this exposure assessment (see also footnotes Tables 16-19):

- The duration of exposure is expected to be short-term (1-7) days based on label directions for multiple (not more than two) applications of atrazine to lawns. None of the currently registered residential or other non-occupational uses would result in intermediate- or long-term exposures.

- Calculations were completed at the maximum application rates for lawns recommended on the available atrazine labels to bracket exposure levels associated with the various use patterns.

- Generally, the use of PPE and engineering controls are not considered acceptable options for products sold for use by residents. Therefore, PHED values represent a handler wearing typical residential clothing attire of short-sleeve shirt, short pants, and no gloves.

- For inhalation dose estimates, the mean female body weight (60 kg) is used as the toxicity endpoint of concern is developmental.

- For dermal dose estimates, the mean body weight of an adult handler was assumed to be 70 kg. since the short-term dermal endpoint is not sex specific.

- An estimate of 0.5 acres (approximately 20,000 ft^2) treated per day was used for push-spreader and hose-end scenarios. One-half acre is assumed to be within the mean to upper-percentile range of the distribution of lawn size.

- Belly grinder application of granular product and backpack or and low-pressure hand wand application of liquid formulation, are assumed to be used for a spot-treatment or areas where push type spreaders would be impractical. The area treated is assumed to be no more than 1000 sq ft. The label does not include (or prohibit) hand spreading of granulated product.

Handler Exposure Study Data:

See the occupational exposure section for a discussion of the atrazine study of lawn care applicators. The ORETF studies of residential handlers applying granular and liquid formulations are summarized briefly here.

Granular Push-Spreader:

A loader/applicator study was performed by the Outdoor Residential Exposure Task Force (ORETF) using Dacthal (active ingredient DCPA, dimethyl tetrachloroterephthalate) as a surrogate compound to determine "generic" exposures of 30 volunteers applying a granular pesticide formulation to residential lawns. The geometric mean of the data were used as the data were mostly lognormally distributed. As the study volunteers only applied to 10,000 ft^2, and the Residential SOP recommends using twice that area for assessments, the unit exposure was extrapolated by a factor of 2 to the standard one-half acre per day.

ORETF Hose-end Spray Exposure Study:

Diazinon was chosen by the Task Force as the surrogate chemical for hose-end sprayers. A mixer/loader/applicator study was performed by the Outdoor Residential Exposure Task Force (ORETF) using diazinon (25% EC) as a surrogate compound to determine "generic" exposures to 30 individuals applying a pesticide to turf with a garden hose-end sprayer. Dermal and inhalation exposures

were estimated using passive dosimetry techniques. A nominal application rate of 4 lb ai/acre was used for all replicates. Each replicate monitored the test subject treating 5,000 ft2 of turf and handling a total of 0.5 lb ai/replicate. This study data is of greater quality and confidence than the current PHED data for hose-end spray. Due to extrapolation to ½ acre (a 4x increase) the geometric mean of the data was used, rather than the mean or 90th percentile, to avoid overestimating.

Residential Handler Exposure and Risk Estimates

The calculations of daily dermal and inhalation exposure to atrazine were used to calculate short-term dermal and inhalation doses, and hence the risks for residential handlers. The short-term dermal and inhalation doses were also aggregated. The MOE target for residential dermal or inhalation short-term exposure is 1000; MOEs greater than these do not exceed the HED's level of concern. Tables 16a & 16b present the residential dermal short-term doses and the MOEs associated with the residential handling of atrazine using PHED and ORETF data, respectively. The following formulae were used in calculation of dermal exposure, short-term dose and MOE.

Potential daily exposures were calculated using the following formulae:

$$\text{Daily Dermal Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) = \text{Unit Exposure}\left(\frac{\text{mg ai}}{\text{lb ai}}\right) \times \text{Use Rate}\left(\frac{\text{lb ai}}{A}\right) \times \text{Daily Acres Treated}\left(\frac{A}{\text{day}}\right)$$

$$\text{Daily Inhalation Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) =$$
$$\text{Unit Exposure}\left(\frac{\mu\text{g ai}}{\text{lb ai}}\right) \times \text{Conversion Factor}\left(\frac{1\text{mg}}{1{,}000\ \mu\text{g}}\right) \times \text{Use Rate}\left(\frac{\text{lb ai}}{A}\right) \times \text{Daily Acres Treated}\left(\frac{A}{\text{day}}\right)$$

Short-term inhalation and dermal doses (incidental oral ingestion is not considered a significant exposure route for adults) were calculated using the following formulae:

$$\text{Daily Dose}\left(\frac{\text{mg ai}}{\text{kg/day}}\right) = \text{Daily Exposure}\left(\frac{\text{mg ai}}{\text{day}}\right) \times \left(\frac{\text{Absorption Factor}\left(\frac{\text{percent}}{100}\right)}{\text{body weight (kg)}}\right)$$

where: inhalation absorption factor is assumed to be 100 percent or 1

where: dermal absorption factor = 100 percent or 1 (dermal toxicity study used)

- Full lawn treatment: ½ Acre x 1 to 2 lb ai/acre (depending on formulation) = 0.5 to 1 lb ai/day

- Spot-treatment: 1,000 ft^2/day x (1 to 2 depending on formulation) lb ai/acre = 0.023 to 0.045 lb ai/day

The following formula was used in the calculation of the short-term MOEs:

$$\text{MOE (unitless)} = \frac{\text{NOAEL (mg / kg / day)}}{\text{Daily Dose (mg / kg / day)}}$$

Aggregate MOEs for short-term exposures were calculated using the following formula:

$$\textit{Aggregate MOE} = \frac{1}{\frac{1}{\text{dermal MOE}} + \frac{1}{\text{inhalation MOE}}}$$

The same formula will be used for aggregating dermal, inhalation, and/or oral risks, as needed.

Handler Scenarios with Risk Concerns

None of the residential handler scenarios had short-term dermal risks of concern. Dermal and inhalation exposure MOEs were all greater than 1000 and aggregate MOES ranged from 2200-110,000. (Tables 16a & 16b)

Data Gaps

Surrogate data from passive dosimetry studies were available for each application method. Atrazine-specific handler exposure data were only available for closed mixing/loading systems and enclosed cab application by ground spray. The quality of data is discussed below.

Data Quality and Confidence in Assessment

Several issues must be considered when interpreting the resident handler risk estimates:

- The belly grinder method (like other hand-controlled applications) is a low-confidence estimate, but is considered to be generally conservative. If hand application methods are to be prevented, the labeling should explicitly specify.

- The scenarios based on ORETF studies were extrapolated from the lower acreages applied in the studies by simple proportion, and this process may statistically overestimate the risk because the rate of residue increase on skin generally decreases somewhat after a certain (undetermined) level. However, the geometric mean value was used in order to offset the extrapolation and help represent a more typical, rather than high-end, dose.

- The use of one-half an acre for residential applications is based on the Residential SOPs which states this is the 90th percentile size lawn and is therefore a high-end estimate, but not a maximum. The label-recommended use of atrazine lawn products as weed prevention in spring and/or fall may support it's use on the entire lawn, rather than as a spot treatment, since weeds may not be present at those times.

- The liquid backpack and low-pressure handwand scenarios used low-confidence PHED data were from estimates found in the Residential SOPs. The backpack scenario had insufficient replicates (only 11), while the low-pressure handwand had low quality data.

- Pending final peer-review, the data from the ORETF studies has been classified as medium-to-high confidence level, due to adequate numbers of replicates and quantifiable samples (above the limit of detection.) The decision has not been made as to how to compare these data to that of the PHED v. 1.1.

Non-Occupational Postapplication Exposures and Risk Estimates

The Agency has determined that there are potential postapplication exposures to residents entering atrazine treated lawns, either as a result of commercial or private application.

Postapplication Exposure Scenarios

The scenarios likely to result in postapplication exposures are presented below. The duration of postapplication dermal exposure is expected to be either short-term or intermediate-term, based atrazine turf residue dissipation data. The initial transferable residues from spray application were much higher (10x) than granular residues, but both declined slowly. As calculated from the study data, atrazine has a half-life on turf of up to 5 days after spraying or 9 days after granular application, requiring several weeks to dissipate to nondetectable levels of transferable residues. Because the label prohibits application more than twice per year, and even with the slow dissipation rates, it is not expected that individual residential exposure duration would exceed 30 days in duration. Exposure on a residential lawn would diminish continuously with time, while exposure through recreation turf contact would be more like random intermittent events of varying doses, all less than the dose predicted in this assessment. The resulting risk estimates are summarized in Table 17. Residential postapplication exposure assessments assumed residents wear the following attire: short sleeved shirt, short pants, shoes and socks, and no gloves or

respirator. As stated in the occupational postapplication risk section of this document, negligible atrazine inhalation exposure is anticipated for non-handlers, due to low chemical vapor pressure and dilution of vapor outdoors (this is borne out in handler study data). The scenarios likely to result in postapplication exposures are as follows:

- dermal postapplication risks to adults and children when entering atrazine treated turf and lawns;

- oral postapplication risks to children from "hand-to-mouth" (i.e., ingestion of grass, soil, granular pellets, or hand-to-mouth contact) exposure when reentering lawns treated with granular and spray formulations.

Representative turf reentry activities include, but are not limited to:

(1) Adults involved in a low exposure activity, such as golfing or walking on treated turf.
(2) Adults mowing or other moderate contact activity, for 1-2 hours.
(3) Adults involved in a high exposure activity, such as heavy yard work (doses similar to occupational scenarios for cutting and harvesting sod**).**
(4) Children involved in high exposure activities on turf.

Summary of Postapplication Spray Drift/Track-In Risks

HED recognizes that there may be concerns for the potential for children's exposure in the home as a result of agricultural uses of atrazine. Environmental concentrations of atrazine in homes may result from spray drift, track-in, or from redistribution of residues brought home on the farmworker's clothing. Potential routes of exposure for children may include incidental ingestion and dermal contact with residues on carpets/hard surfaces. Studies are currently being pilot-tested which will look for sources of major pesticide (including atrazine) exposure and attempt to quantify those exposures. A large study in the National Hazard Assessment Exposure Assessment Survey (NHEXAS) program [MacIntosh, et al., 1999] has thus far detected no or extremely low (less than 1 percent detectable, less than one ug per gram creatinine) levels of atrazine in 80 participants in Maryland.

This assessment reflects the Agency's current approaches for completing residential exposure assessments based on the guidance provided in the *Draft: Series 875-Occupational and Residential Exposure Test Guidelines, Group B-Postapplication Exposure Monitoring Test Guidelines*, the *Draft: Standard Operating Procedures (SOPs) for Residential Exposure Assessment*, and the *Overview of Issues Related to the Standard Operating Procedures for Residential Exposure Assessment* presented at the September 1999 meeting of the FIFRA Scientific Advisory Panel (SAP). The Agency is, however, currently in the process of revising its guidance for completing these types of assessments. Further research into children's exposures resulting from agricultural uses of pesticides are being conducted by the Agency's

Office of Research and Development through the STAR (Science to Achieve Results) grant program. The STAR program can be accessed at ***http://es.epa.gov/ncerqa/grants/*** Modifications to this assessment shall be incorporated as updated guidance becomes available. This will include expanding the scope of the residential exposure assessments by developing guidance for characterizing exposures from other sources already not addressed such as from spray drift; residential residue track-in; and exposures to farm worker children.

Data Sources for Scenarios Considered

Two turf transferable residue studies, using a granular and a spray application, were described in the Occupational Postapplication exposure section of this document. As the studies were found to be acceptable for the risk assessment, the highest mean residues were also used to estimate short-term (DAT 0-1) and intermediate term (DAT 7) postapplication re-entry exposure for adults and children contacting atrazine treated turf.

Only limited information was received regarding the size and distribution of granular formulations. This information would help to refine or characterize the estimate of potential risk from episodic incidental ingestion of granules beyond the current screening level. For example, the "weed and feed" (fertilizer/herbicide combination) granules would be considered more attractive and more likely to be consumed if readily visible and easily picked up by a child. The granular product was described by Scotts as having the size of "beach sand." If the particles are very fine, individual grains would be difficult to pick up, or even to see when applied on a lawn and if used according to label directions and soil incorporated, it is unlikely that Atrazine granules would be accessible to a child. However, larger granules or pellets of a few millimeters diameter might be attractive and easily picked up by a young child. Even a very small amount, less than a teaspoon of atrazine-containing "weed and feed" lawn fertilizer, if mouthed and swallowed by a small child would exceed the toxic level of concern. Therefore HED recommends that the potential for children's exposure to Atrazine granules be mitigated through stringent label requirements for watering-in and spill clean-up.

All residential scenarios, where possible, utilized the atrazine TTR study data, which were based upon the maximum label application rates. Children's exposure levels were calculated for the residential exposure assessment and for the purposes of completing an aggregate risk assessment that also considers exposure from dietary intake of food and water.

Assumptions Used in Postapplication Exposure Calculations

Dermal Exposure values on each day after application were calculated based on the following equation (see Residential 2.2 (1997): Postapplication dermal potential dose from pesticide residues on turf):

$DE_{(t)}$ (mg/day) = ($TTR_{(t)}$ (µg/cm^2) x TC (cm^2/hr) x Hr/Day)/1000 (µg/mg)

Where:

DE = Dermal exposure at time (t) attributable for activity in a previously treated area (mg/day);
TTR= Turf Transferable Residue at time (t) where the longest duration (t) is dictated by the kinetics observed in the TTR study;
TC = Transfer Coefficient; and
Hr = Exposure duration in hours.

The activities that were selected as the basis for the risk assessment are represented by the following transfer coefficients (for short-term endpoints):

- **Transfer Coefficient = 500 - 1000 cm^2/hour** for adults involved in a low exposure activity on turf such as golfing or light work activities;
- **Transfer Coefficient = 14,500 cm^2/hour** for adults involved in a high exposure activity on turf such as heavy yard work or laying sod; and
- **Transfer Coefficient = 5,200 cm^2/hour** for children (1-6 year olds) involved in a high exposure activity. Based on the proposed changes to the Residential SOPs, transfer coefficients of 14,500 cm^2/hr for adults and 5,200 cm^2/hour for small children were used to calculate dermal exposures to treated turf.

The Agency's Residential SOPs contains guidance for considering children's exposure to treated turf. The dermal calculations, as noted above, were completed based on the guidance provided in the document. All nondietary exposures were also calculated using guidance from this document. Specifically, the kinds of nondietary exposures that were considered in this assessment include the following:

- **Dose from eating granules calculated using Residential SOP 2.3.1:** Postapplication potential dose among children from incidental nondietary ingestion of pesticide granules in the treated area.
- **Dose from hand to mouth activity calculated using Residential SOP 2.3.2:** Postapplication potential dose among small children from incidental nondietary ingestion of pesticide residues on residential lawns from hand-to-mouth transfer.
- **Dose from mouthing treated turf calculated using Residential SOP 2.3.3:** Postapplication potential dose among children from the ingestion of pesticide treated turfgrass; and
- **Dose from incidental ingestion of soil calculated using Residential SOP 2.3.4:** Postapplication potential dose among children from the ingestion of soil in pesticide treated areas.

Although incidental exposures incurred by hand-to-mouth exposure are included as part of the nondietary risk assessment, these type of exposures are considered *episodic* in nature. Therefore, the granular ingestion is assessed as an individual event and is not aggregated with any other nondietary

exposure. The hand-licking, mouthing of turf, and eating of soil are considered more likely to co-occur, and thus are aggregated. Note that the hand-licking scenario constitutes the largest incidental oral exposure component (see Table 18).

This first formula illustrates the method of calculating granular ingestion by children (SOP 2.3.1):

PDR = IgR x F x CF1

where:

PDR = potential dose rate (mg/day)
IgR = ingestion rate of granular formulation (g/day)
F = fraction of ai in dry formulation (unitless)
CF1 = weight unit conversion factor to convert grams to milligrams (1000 mg/g)

It is assumed in the Residential SOP that a maximum of 0.3 gm/day dry pesticide will be ingested by young children. This is based on an application rate of 150 lb formulated product to a half acre. The amount of product per square foot would be approximately 3 g/ft^2, and a child is assumed to consume one-tenth of the product available in a square foot. This is believed to be an upper-percentile estimate. Since atrazine labels vary from 100-200 lb formulated product per half acre (or 22,000 ft^2), the maximum ingestible granules was adjusted to 0.2-0.4 grams/day. The fraction of ai in granular formulations of atrazine varies from 0.42 to 1.5%.

The following demonstrates the method used to calculate exposures that are attributable to a child touching treated turf and then putting their hands in their mouth (SOP 2.3.2, revised 2000):

$$PDR = (DFR * EF * SA * Freq * Hr * (1mg/1000\mu g))$$

where:

PDR = potential dose rate (mg/day)
DFR(t) = Dislodgeable Residue (5%) on day of treatment (µg/cm^2);
EF = saliva extraction factor of 50% of total DFR;
SA = surface area of two fingers (cm^2);
Freq = frequency of hand-to-mouth events (events/hour); and
Hr = exposure duration (hours).

As indicated above, the dislodgeable foliar residue represents the amount of pesticide that can be removed from turf by the (potentially wet) hands of a child, while the turf transferable residue represents the amount of chemical on the surfaces of treated leaves that can rub off on dry skin or clothing. The methodology used to obtain a TTR value could underestimate incidental oral exposures to children. The TTR data are designed to assess dermal exposure to pesticides using the choreographed activity Jazzercise,

measured on dry cotton dosimeters, and do not address the transferability of residues by hands wetted with saliva. The 5% transfer factor is based on data by Clothier (1999). Dislodgeable foliar residue (not atrazine) data from a 1984 California study (MRID 402029-01) based on washing grass clippings report average DFRs of 0.8% to 5.7%, depending on methodology. These observations are based on empirical data, and therefore the Residential SOP standard 5% of the amount ai applied is used, rather than the data from the TTR study. The surface area for 1-3 fingers used (20 cm^2) is the median surface area for a toddler (age 3 years) as updated by the SAP meeting in 1999. The frequency of hand-to-mouth events is 20 events per hour as updated in the 1999 SAP meeting. The 2 hour duration value is a recommended value from the U.S. EPA Exposure Factors Handbook. This model for hand-to-mouth dose is based on the premise that a child puts 2-3 fingers in their mouths, 50% of the residues on the hands are transferred from the hands to the mouth (Extraction Factor), and that all of the dislodgeable residues available on the treated turf transfer to the child's hand each time they exhibit this behavior.

The following illustrates the approach used to calculate exposures that are attributable to a object-to-mouth exposure scenario, such as a child mouthing treated turf (SOP 2.3.3, revised 2000):

$$PDR = (DFR * IgR * (1mg/1000\mu g))$$

where:

PDR	=	potential dose rate (mg/day);
DFR(t)	=	Dislodgeable Foliar Residue (DFR) at time (t) where the longest duration (t) is dictated by the kinetics observed in the TTR study ($\mu g/cm^2$);
EF	=	saliva extraction factor of 50% of total DFR; and
IgR	=	ingestion rate for mouthing of grass (or other object) per day (cm^2/day).

Lacking DFR data for atrazine on turf, the Agency chose to translate the DFR data from the corn study, normalized for lbs ai/acre applied. The methodology used to dislodge residues in the DFR study more closely resemble a treated object (i.e., turf) being placed entirely in the mouth of a small child than the TTR data. The ingestion rate used (25 cm^2/day) assumes that a child will grab a handful of turf, or a small object, mouth it and remove some atrazine residues, and then remove it from their mouth as described in the Residential SOPs. The standard time period is 2 hours, as explained above. The surface area of (25 cm^2/day) is thought to approximate a handful of turf or a small object that is mouthed.

Incidental Soil Ingestion:

$$PDR = (SR_t * IgR * CF1)$$

where:

PDR	=	potential dose rate (mg/day)
SR_t	=	soil residue on day "t" ($\mu g/g$), assuming average day of reentry "t" is day 0

IgR = ingestion rate of soil (mg/day), assumed to be 100 mg/day
CF1 = weight unit conversion factor to convert the µg of residues on the soil to grams to provide units of mg/day (1E-6 g/µg)

and

$$SR_t = AR * F * (1-D)^t * CF2 * CF3 * CF4$$

where:

AR = application rate (lb ai/acre)
F = fraction of ai available in uppermost cm of soil (fraction/cm), assumed to be 100 percent based on soil incorporation into top 1 cm of soil after application
D = fraction of residue that dissipates daily (unitless)
t = postapplication day on which exposure is being assessed
CF2 = weight unit conversion factor to convert the lbs ai in the application rate to µg for the soil residue value (4.54×10^8 µg/lb)
CF3 = area unit conversion factor to convert the surface area units (ft^2) in the application rate to cm^2 for the SR value (2.47×10^{-8} acre/cm^2 if the application rate is per acre)
CF4 = volume to weight unit conversion factor to convert the volume units (cm^3) to weight units for the SR value (0.67 cm^3/g soil)[7]
t = postapplication day on which exposure is being assessed, assumed to be day zero

The following specific assumptions and factors were used in order to complete this exposure assessment:

- These assessments were based on the guidance provided in the Residential SOPs as updated after the Fall 1999 SAP meeting (described above). Several of the assumptions and factors used in the exposure assessment are described in that document.

- Calculations are completed at the maximum application rates recommended by the available atrazine labels to bracket risk levels associated with the various use patterns and activity scenarios. Although "typical"and average rates have been supplied, the atrazine labels generally reflect a recommended rate for granular and liquid formulations which is at or close to the 2.0 lb ai/acre limit. The granular and spray turf residue data which were submitted also use the 2.0 lb ai/acre application rate. These were normalized to an exposure of mg/lb ai handled.

- Due to a lack of scenario-specific exposure data, HED has calculated exposure values for adults using surrogate dermal transfer coefficients that represent activities such as mowing, golfing, and yard work. Most of the transfer coefficients used are based on data submitted by the ARTF and ORETF and are reflected in the revised HED exposure guidance Policy 3.1 (8/2000).

- For the short- and intermediate-term risk assessment, the equations and assumptions used for each of the scenarios were taken from the Residential SOPs guidance document.

- Chemical-specific turf transferable residue data was used for estimation of dermal exposures.

- Chemical-specific dislodgeable foliar residue data was translated from a corn study for dislodgeable turf residue in the mouthing activity of small children.

- Adults were assumed to weigh 70 kg for the short-term postapplication dermal dose estimate and 60 kg for the intermediate-term dermal postapplication dose estimate. Young children and toddlers are represented by a 15 kg 3 year old, as recommended in the Residential SOPs.

- Postapplication exposure is generally assessed on the same day the pesticide is applied because it is assumed that the resident could be exposed to turf immediately after application. However, because atrazine TTR study data indicate transferable residues are *greater* after the day of application, the highest average daily residue from each site has been used for the screening risk estimate.

- A dermal absorption factor of 6 percent was used in the calculation of intermediate-term postapplication dermal dose. MOEs were calculated using the same formula (NOAEL divided by absorbed dermal dose) described in the residential handler portion of this chapter, and are considered to be below the level of concern when results are greater than 1000.

Postapplication Exposure Risk Estimates

Dermal exposure estimates were conducted using the actual average TTR study residues from each site and the set of standard assumptions outlined above (see Table 17). Two of these scenarios, both involving application of a liquid formulation, had short-term dermal MOEs less than 1000, for high-contact activities on turf for the child (MOE = 390) and adult (MOE=660). Residues had dissipated sufficiently by the 2nd day after treatment to raise MOEs for children to 2600 and adults to 4500. For granular treatments, all postapplication MOEs were greater than 1000 (range 4,000 - 120,000 for adults; 2,400 for high contact activity for child). For adults golfing and mowing on treated turf, all short-term dermal MOEs exceeded 1000. Assuming <u>all</u> of the adult dermal exposures (golfing, mowing, high-contact activities) would happen in one day over 8 hours, the aggregate dermal MOE ranges from 600 to 14,000, with the lower MOEs based on the spray application residues. This high-end aggregate risk estimate is driven by the single adult and child 'high-contact activity' scenario of concern.

It is possible for an adult resident to apply atrazine by one of several methods to their lawn, then, later that same day, take part in activities on the lawn, such as sports. Only liquid application and post-application activity would result in a risk of concern. Therefore, the aggregated dose from applying atrazine

by hose-end spray and then playing on the treated lawn (the highest exposure estimates) on the same day yields an MOE of 510. This should be considered a high-end, screening level exposure estimate.

Lacking dislodgeable residue data (because children's hands may be wet and sticky and TTR data was obtained with dry wipe methods), the Residential SOPs were used to estimate incidental oral exposure for toddlers (young children) licking their fingers after touching treated turf. Therefore, the risk estimate for finger licking is based on the application rate of 2 lbs ai/acre, and formulation is not a factor. Because dislodgeable foliar residue were provided for corn, but not for turf, the corn dfr, normalized for a 2 lb ai/acre application rate, was applied to the turf (or treated object) mouthing scenario. The finger-licking MOE alone was 330, while mouthing grass and soil ingestion MOEs (1800 and 100,000, respectively) were both greater than 1000. The aggregated (finger licking + mouthing grass + soil ingestion) incidental ingestion MOE was 280. Incidental ingestion of atrazine granules was not aggregated, as it is considered episodic in nature, but all scenarios had MOEs of concern (single dose; 0.42%-1.5% ai; MOE 25-180).

A single label for atrazine 4L (EPA Reg. No. 829-268) permits professional application to "corn in the home garden." As this was the only such label use found, the potential postapplication risk to residents was not quantitatively assessed; but as the potential risk estimated for postapplication workers was low, the residential risks are also considered low.

Aggregate Exposure Estimates

Adults may reasonably be expected to perform more than one activity on treated lawns in a single day, but an eight-hour exposure is considered unlikely. Therefore it is considered reasonable to add the exposures from playing/gardening (highest exposure rate), walking, and mowing (lower exposure rate) for a single MOE. Excepting the highest exposure activity on the liquid-treated turf, the aggregate MOE would be greater than the target 1000. The aggregate postapplication MOE for all activities on liquid-treated turf is at least 600 for adults. The lowest aggregated MOE for all activities on granular-treated turf is 3600 for adults. Small children are not expected to have significant gardening or mowing exposures, and the jazzercise exposure model is considered sufficiently conservative to cover daily dermal exposures. It is possible, if not very likely, that an adult would apply herbicide spray to a lawn and then play on it or mow it later that day. In such an event, the aggregated dermal MOE for the day was 510 for hose-end spray, using ORETF exposure values. This is considered a high-end estimate of potential exposure.

It is considered reasonably likely that dermal and oral incidental exposures may occur in the same day for children playing on atrazine-treated lawn. It can be seen from calculations presented in Table 18 that the incidental hand-to-mouth (licking fingers) exposure estimate constitutes most of the aggregate non-dietary oral dose. The overall MOE is only slightly less (280) than the MOE for the hand-to-mouth estimate. The individual dermal and oral routes of exposure each exceed the level of concern, and adding them mathematically produces an even lower MOE of 170. These route-specific and dermal + oral aggregated doses and MOEs were calculated for the purposes of the overall risk assessment for this chemical, which

will consider all routes of exposure. Finally, ingestion of granules, as explained earlier, is not aggregated because it is considered an infrequent, episodic event.

Summary of Postapplication Risk Concerns

There is a risk concern (i.e., MOE<1000) for adult or child residential exposures during the early (less than seven days) postapplication period when playing/working intensively on turf, using the higher average residues measured during the day of application from the spray TTR study. After the first postapplication day, there is no longer a dermal exposure level of concern. Therefore, based on the study data, applying a liquid formulation and using the lawn the same day may cause an exposure of concern for adults or for the children playing on the lawn. These were the only dermal exposure scenarios of concern for either adult or child.

Children's finger licking after touching treated turf, or the actual ingestion of granules are the two incidental oral ingestion scenarios of concern. Of these, the finger licking is considered most representative of actual events. This hand-to-mouth dose exceeds the short-term level of concern (MOE = 330). The opportunity for incidental ingestion of granules may be reduced by the relatively small particle size, but labeling statements should also advocate prompt watering-in and clean up of spillage.

Data Gaps and Uncertainties

The following data gaps or uncertainties were associated with this assessment:

- Oral ingestion scenarios are based on standard assumptions and formulae (Residential SOPs) which are designed to be screening level.
- The day of application TTR values from each site were used for this risk assessment due to the variability of data between the study sites. The risk estimates therefore represent the higher end of the exposure range, but are not considered maximum values. The TTR studies were conducted without watering-in; watering-in sometimes reduces residues, and is recommended on the label (as atrazine is a systemic herbicide).
- Granular ingestion is considered episodic, rather than continuous, in nature.
- Additional data regarding granular size and product breakdown with and without watering-in would help characterize the risk to children from granular ingestion.

Recommendations

The deterministic postapplication residential risk assessment, which used the highest reported residue levels, resulted in MOEs which exceed the Agency's level of concern. A probabilistic approach to the use of the various residue study data, application rates, areas treated per day, etc., would help to refine the risk estimates.

Current labeling should be strengthened to prevent accidental ingestion by children, and the watering-in requirement is important.

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ATRAZINE

EXPOSURE AND RISK ESTIMATES

TABLES 1-18

Table 1. Acute Toxicity Categories for Atrazine

Guideline No.	Study Type	MRIDs #	Results	Toxicity Category
81-1	Acute Oral	Acc 230303	LD_{50} = 1,869 mg/kg (M+F combined)	III
81-2	Acute Dermal	Acc 230303	LD_{50} > 2,000 mg/kg (M+F combined)	III
81-3	Acute Inhalation	430165-02	LC_{50} > 5.8 mg/L (M+F combined)	IV
81-4	Primary Eye Irritation	Acc 230303	PIS= 0.0/110	IV
81-5	Primary Skin Irritation	Acc 230303	PIS= 0.2/8.0	IV
81-6	Dermal Sensitization	001051-31	Non-sensitizing	IV
81-7	Acute Neurotoxicity	none	Not Applicable	—

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Table 2. Toxicity Endpoints for Assessing Occupational and Residential Risks for Atrazine

The doses and toxicological endpoints selected for various exposure scenarios are summarized below.

EXPOSURE SCENARIO	DOSE (mg/kg/day)	ENDPOINT	STUDY
Acute Dietary	NOAEL= 10 UF = 100	Delayed ossification of certain cranial bones	Developmental toxicity in 4 rat & rabbit studies
	Acute RfD = 0.1 mg/kg/day		
Chronic Dietary	NOAEL = 1.8 UF = 100	Attenuation the pre-ovulatory luteinizing hormone (LH) surge	Six-month LH surge study in the rat
		Chronic RfD = 0.018 mg/kg/day	
Incidental Oral, Short-Term	NOAEL= 10 UF x FQPA = 1000	Decreased body weight during the first five days of dosing in the dams	Developmental toxicity study in the rat
Incidental Oral, Intermediate-Term	NOAEL= 1.8 UF x FQPA = 1000	Attenuation of the pre-ovulatory luteinizing hormone (LH) surge as indicative of hypothalamic disruption	Six-month LH surge study in the rat
Dermal, Short-Term[a]	NOAEL= 360 (NOAEL from study was 100 mg/kg/day. Multiplied by the rat:human dermal penetration factor of 3.6 = 360 mg/kg/day) Occupational UF = 100 Residential UF x FQPA=1000	reductions in food consumption, mean body weight, and percent weight gain in both sexes, statistically significantly increased absolute and relative spleen weights in both sexes, and slight changes in excretion (*i.e.* few and/or mucoid feces).	21-day dermal toxicity study in rabbit
Dermal, Intermediate-Term[b]	NOAEL= 1.8 Occupational UF = 100	Attenuation of the pre-ovulatory luteinizing hormone (LH) surge as indicative of hypothalamic disruption	Six-month LH surge study in the rat
Dermal, Long-Term [b]	NOAEL= 1.8 Occupational UF = 100	Same as intermediate term	Same as intermediate term
Inhalation, Short-Term [c]	NOAEL= 10 Occupational UF = 100 Residential UF x FQPA=1000	Decreased body weight during the first five days of dosing in the dams	Developmental toxicity study in the rat
Inhalation, Intermediate-Term [c]	NOAEL= 1.8 Occupational UF = 100	Attenuation of the pre-ovulatory luteinizing hormone (LH) surge indicative of hypothalamic disruption	Six-month LH surge study in the rat
Inhalation, Long-Term [c]	NOAEL= 1.8 Occupational UF = 100	Same as intermediate term	Same as intermediate term

a The rat:human dermal penetration factor of 3.6 is applied to this scenario only.

b Dermal absorption rate = 6%

c Convert from oral dose using an inhalation absorption rate= 100% default

Table 3: Atrazine: Occupational Handler Short-term and Intermediate-term Risk Estimates; Based on Field Monitoring of Atrazine Handlers Using Engineering Controls (Biomonitoring and Passive Dosimetry Studies)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	Data Type and Source	Engineering Control Unit Exposure (mg/lb ai)		Short-Term Risks				Intermediate-Term Risks			
							Dose (mg/kg/day)		Engineering Control MOE		Dose (mg/kg/day)		Engineering Control MOE	
					Geo Mean	90th Percentile	Geo Mean	90th Percentile	Geo Mean	90th Percentile	Geo Mean	90th Percentile	Geo Mean	90th Percentile
Mixer/Loader														
Mixing/Loading Liquid Formulations for Groundboom Application (1b)	corn, sorghum	2	200	Passive Dosimetry norm by ai (#09/11)	0.00860[c] dosimeters	0.1600[c] dosimeters	0.049[e] dermal	0.91[e] dermal	7,300[g] dermal	390[g] dermal	0.0034[e] abs.drml	0.064[e] abs.drml	520[g] dermal	28[g] dermal
				Biomonitoring norm by ai (#09/11)	0.00058[d] urinary	0.0044[d] urinary	0.0033[f] tot. intrl	0.025[f] tot. intrl	3,000[h] total	400[h] total	0.0039[f] tot. intrl	0.029[f] tot. intrl	470[h] total	61[h] total
		NA	NA	Biomonitoring norm by bw (#05/06)	NA	NA	0.0029[f] tot. intrl	0.012[f] tot. intrl	9,000[h] total	2,600[h] total	0.0029[f] tot. intrl	0.012[f] tot. intrl	630[h] total	150[h] total
		NA	NA	Biomonitoring norm by bw (#09/11)	NA	NA	0.0033[f] tot. intrl	0.013[f] tot. intrl	5,300[h] total	725[h] total	0.0033[f] tot. intrl	0.013[f] tot. intrl	550[h] total	140[h] total
Applicator														
Applying Liquids for Groundboom Application (5)	corn, sorghum	2	200	Passive Dosimetry norm by ai (#09/11)	0.012[c] dosimeters	0.49[c] dosimeters	0.069[e] dermal	2.8[e] dermal	5,300[e] dermal	130[h] dermal	0.0048[e] abs.drml	0.2[e] abs.drml	380[g] dermal	9.2[g] dermal
				Biomonitoring norm by ai (#09/11)	0.00061[d] urinary	0.0069[d] urinary	0.0035[f] tot. intrl	0.039[f] tot. intrl	2,900[f] total	250[h] total	0.0041[f] tot. intrl	0.046[f] tot. intrl	440[h] total	39[h] total
		NA	NA	Biomonitoring norm by bw (#05/06)	NA	NA	0.0011[f] tot. intrl	0.0038[f] tot. intrl	3,500[f] total	820[h] total	0.0011[f] tot. intrl	0.0038[f] tot. intrl	1600[h] total	470[h] total
		NA	NA	Biomonitoring norm by bw (#09/11)	NA	NA	0.0019[f] tot. intrl	0.014[f] tot. intrl	3,100[f] total	790[h] total	0.0019[f] tot. intrl	0.014[f] tot. intrl	960[h] total	130[h] total
Mixer/Loader/Applicator														
Mixing/Loading/ Applying Liquids with Groundboom	corn, sorghum	2	200	Passive Dosimetry norm by ai (#09/11)	0.021[c] dosimeters	0.190[c] dosimeters	0.12[e] dermal	1.1[e] dermal	3,000[h] dermal	330[h] dermal	0.0084[e] abs.drml	0.076[e] abs.drml	210[g] dermal	24[g] dermal
				Biomonitoring norm by ai (#09/11)	0.0039[d] urinary	0.017[d] urinary	0.022[f] tot. intrl	0.097[f] tot. intrl	450[h] total	100[h] total	0.026[f] tot. intrl	0.11[f] tot. intrl	69[h] total	16[h] total
		NA	NA	Biomonitoring norm by bw (#05/06)	NA	NA	0.0042[f] tot. intrl	0.014[f] tot. intrl	2,400[h] total	740[h] total	0.0042[f] tot. intrl	0.014[f] tot. intrl	430[h] total	133[h] total
		NA	NA	Biomonitoring norm by bw (#09/11)	NA	NA	0.0055[f] tot. intrl	0.022[f] tot. intrl	1,800[h] total	460[h] total	0.0055[f] tot. intrl	0.022[f] tot. intrl	330[h] total	83[h] total

NOTE: Exposure scenarios assume engineering controls (closed mixing/loading systems and enclosed cab groundboom application).

a Application rate is the maximum EPA-registered label rate for corn /sorghum..

Table 3: Atrazine: Occupational Handler Short-term and Intermediate-term Risk Estimates; Based on Field Monitoring of Atrazine Handlers Using Engineering Controls (Biomonitoring and Passive Dosimetry Studies) [Continued]

b Acres treated per day value is the EPA estimate found in Exposure SAC Policy # 9 "*Standard Values for Daily Acres Treated in Agriculture*," revised June 23, 2000.

c Engineering control dermal unit exposure values calculated from passive dosimetry data presented in MRID 441521-09/11. Unit exposure = atrazine residue on inner dosimeters including head patch, face/neck wipes, hand washes, legs, t-shirt and briefs, torso / lb ai of atrazine handled per day. Unit exposure values are presented as the geometric mean value and the 90^{th} percentile value.

d Engineering control total internal unit exposure values calculated from biomonitoring data presented in MRID 441521-09/11. Unit exposure = total triazine residue in urine per replicate adjusted (divided by chlorotriazine excretion rate of 0.12) to represent atrazine internal exposure and then divided by total pounds of atrazine active ingredient handled per replicate. Unit exposure values are presented as the geometric mean value and the 90^{th} percentile value.

e Total dermal dose (mg/kg/day) = unit exposure (mg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) / body weight (70 kg adult for short-term and 60 kg developmental female for intermediate-term). For intermediate-term a dermal absorption factor of 6% is also included in the dose calculation.

f Total internal dose is calculated from biomonitoring data presented in MRID 441521-05/06 and 441521-09/11. Total internal dose = highest daily triazine residue in urine per test subject and adjusted (divided by 0.12) to represent atrazine internal exposure and then divided by body weight of the test subject. Then selecting the geometric mean and 90th percentile of all such doses per handler activity (i.e., mixer/loader, applicator, and mixer/loader/applicator. Total internal dose values are presented as the geometric mean value and the 90^{th} percentile value.

g Dermal MOE = NOAEL (360 mg/kg/day for short-term and 1.8 mg/kg/day for intermediate-term) / dermal dose (mg/kg/day).

h Total MOE = oral NOAEL (10 mg/kg/day for short-term and 1.8 mg/kg/day for intermediate-term) / internal dose (mg/kg/day).

norm by ai = data normalized by active ingredient
norm by bw = data normalized by subject body weight
abs. drml = absorbed dermal
tot. intrl = total internal
05/06 = MRID 445976-05/06
09/11 = MRID 441521-09/11

Table 4: Atrazine: Occupational Exposure Scenario Descriptions and Data Sources

Exposure Scenario (Number)	Data Source	Standard Assumptions	Comments
Occupational Mixer/Loader Exposure			
Mixing/Loading Liquid Formulations (1a, 1b, 1c, 1d., 1e, and 1f)	PHED V1.1	1,200 and 350 acres for aerial, 450 (based on study), 200, 80 and 40 acres groundboom; 40 acres for roadsides or rights-of-way; 100 acres for lawn handgun application (M/L for 20 trucks capable of treating 5 acres each); and an unknown volume of liquid fertilizer.	**Baseline:** Dermal (72-122 replicates); hand (53 replicates); and inhalation (85 replicates) exposure values are all based on AB grade data. High confidence in the unit exposure values. No protection factors were needed to define the unit exposure values. **PPE:** The same dermal and inhalation data are used as for the baseline coupled, when needed, with a 50% protection factor to account for an additional layer of clothing and a 80% protection factor to account for the use of a dust/mist respirator. Gloved-hand (59 replicates) exposure value is based on is based on AB grade data. High confidence in the unit dermal exposure value. **Engineering Controls (closed mixing systems):** Dermal (31 replicates), gloved-hand (31 replicates), and inhalation (27 replicates) exposure values are based on AB grade data. High confidence in the dermal unit exposure value. Low confidence in inhalation unit exposure value. No protection factors were needed to define the unit exposure value.
	Novartis MRID 443154-04 combined with PHED V1.1	same as above	**Baseline and PPE:** no data **Engineering Controls: (closed mixing systems)**: PHED as listed above; MRID 443154-04 dermal, gloved-hand, and inhalation (14 replicates) .

Table 4: Occupational Exposure Scenario Descriptions for the Use of Atrazine (continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions	Comments
Mixing/Loading Dry Flowable Formulations (2a, 2b, 2c)	PHED V1.1	1,200 (high acreage) and 350 acres for aerial; 450 (based on corn study), 200, 80 and 40 acres for groundboom; 40 acres for roadsides / rights-of-way	**Baseline:** Dermal (16-26 replicates); hand (7 replicates); and inhalation (23 replicates) exposure values are all based on AB grade data. Low confidence in hand/dermal data due to the low number of hand replicates. High confidence inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same dermal and inhalation data are used as for the baseline coupled, when needed, with a 50% protection factor to account for an additional layer of clothing and a 80% protection factor to account for the use of a dust/mist respirator. Hand (21 replicates) exposure values are based on AB grade data. High confidence in the dermal unit exposure value. **Engineering Controls (water soluble packets):** Gloved-hand (5 replicates) and dermal (6-15 replicates) exposure values are based on AB grade data. Inhalation (15 replicates) exposure value is based on all grade data. No protection factor was needed to define the unit exposure value.
Loading Granular Formulations (3)	PHED V1.1	80 acres for sod farms and 40 acres for golf course turf	**Baseline:** Hand (10 replicates) exposure values are based on all grade data, dermal (33-78) exposure values are based on ABC grade data , and inhalation (58 replicates) exposure values are based on AB grade data. Low confidence in hand/dermal data, and high confidence in inhalation data. No protection factor was needed to define the unit exposure value. **PPE:** The same inhalation data are used as for the baseline coupled with an 80% protection factor to account for the use of a dust/mist respirator. Hand (45 replicates) and double layer (12-59 replicates) exposure values are based on ABC grade data. Medium confidence in baseline + gloves data; low confidence in double layer + gloves data. . **Engineering Controls (Lock 'n Load):** The same data are used as for baseline coupled with a 98% protection factor to account for Lock 'n Load.

Table 4: Occupational Exposure Scenario Descriptions for the Use of Atrazine (continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions	Comments
Occupational Applicator Exposure			
Aerial Spray Application (4)	PHED V1.1	350 acres 1200 acres for high-acreage crops	**Baseline and PPE: I**nsufficient data. **Engineering controls (enclosed cockpit) :** Dermal (24 to 48 replicates) and inhalation (23 replicates) exposure values are based on ABC grade data. Hand (34 replicates) exposure value is based on AB grade data. Medium confidence in the unit exposure values. No protection factors were needed to define the unit exposure
Groundboom Application (5)	PHED V1.1	450 (based on corn study), 200, 80, and 40 acres	**Baseline:** Dermal (23 to 42 replicates); hand (29 replicates); and inhalation (22 replicates) exposure values are based on AB grade data. High confidence in the unit exposure values. No protection factors were required to define the unit exposure value. **PPE:** The same dermal and inhalation data are used as for the baseline coupled, if needed, with a 50% protection factor to account for an additional layer of clothing and an 80% protection factor to account for the use of a dust/mist respirator. Gloved-hand (21 replicates) exposure value is based on ABC grade data. Medium confidence in the unit exposure value. **Engineering Controls (enclosed cab):** Dermal (20 to 31 replicates) and hand (16 replicates) exposure values are based on ABC grade data. Inhalation (16 replicates) exposure value is based on AB grade data. Medium confidence in dermal unit exposure value, and high confidence in the inhalation unit exposure value. No protection factors were required to define the unit exposure value.
	Novartis MRID 443154-04	same as above	**Baseline and PPE:** no data **Engineering Controls: (enclosed cab)**: PHED as listed above; MRID 443154-04 dermal, hand, and inhalation (14 replicates) .

Table 4: Occupational Exposure Scenario Descriptions for the Use of Atrazine (continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions	Comments
Applying Liquids with Rights-of-Way Sprayer (6)	PHED V1.1	40 acres	**Baseline:** Dermal (4 to 20 replicates) exposure value is based on ABC grade data. Hand (16 replicates) exposure value based on AB grade data and inhalation (16 replicates) exposure value is based on A grade data. Low confidence in the dermal unit exposure value and high confidence in the inhalation data. No protection factors were needed to define the unit exposure value. **PPE:** The same dermal and inhalation data are used as for the baseline coupled, if needed, with a 50% protection factor to account for an additional layer of clothing and an 80% protection factor to account for the use of a dust/mist respirator. Gloved-hand (4 replicates) exposure value is based on AB grade data. Low confidence in the dermal/hand unit exposure value. **Engineering Controls:** Not available for this scenario.
Applying Liquids with a Handgun (7)		5 acres	**Baseline:** Inhalation (14 replicates) exposure value is based on B grade date. Low confidence in inhalation data. **PPE:** Hand (14 replicates) and dermal (0-14 replicates) exposure values are based on C grade data. Low confidence in hand/dermal data. If needed, a 50% protection factor is applied to the dermal data to account for an additional layer of clothing. The same inhalation data are used as for the baseline coupled with an 80% protection factor to account for the use of a dust/mist respirator. **Engineering Controls:** Not available for this scenario

Table 4: Occupational Exposure Scenario Descriptions for the Use of Atrazine (continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions	Comments
Applying with a Tractor Drawn Spreader (8 and 9)		200 (high acreage crop), 80 and 40 acres (golf course)	**Baseline:** Dermal (1-5 replicates); hand (5 replicates); and inhalation (5 replicates) exposure values are all based on AB grade data. Low confidence in the unit exposure values. No protection factors were needed to define the unit exposure values. **PPE:** The same dermal and inhalation data are used as for the baseline coupled, when needed, with a 50% protection factor to account for an additional layer of clothing and an80% protection factor to account for the use of a dust/mist respirator. Gloved-hand (0 replicates) exposure value is low confidence due to lack of data. **Engineering Controls: (enclosed cab):** Dermal (2-30 replicates), hand (24 replicates), and inhalation (37 replicates) exposure values are based on AB grade data. High confidence in the dermal unit exposure value. Low confidence in inhalation unit exposure value. No protection factors were needed to define the unit exposure value.
Occupational Mixer/Loader/Applicator Exposure			
Backpack Sprayer - Liquid Formulations (10)	PHED V1.1	5 acres (full) or **40 gal** 1 acre (spot treatment) [atrazine liquid labels require 40 gal/acre]	**Baseline:** Inhalation (11 replicates) exposure value is based on A grade data. Low confidence in the unit exposure value. No protection factors were needed to define the unit exposure value. **PPE:** Hand (11 replicates) exposure value data is based on C grade data. Dermal (9-11 replicates) exposure value is based on AB grade data. Low confidence in hand/dermal data. If needed, a 50% protection factor is applied to the dermal data to account for an additional layer of clothing. The same inhalation data are used as for the baseline coupled with an 80% protection factor to account for the use of a dust/mist respirator. **Engineering Controls:** Not available for this assessment.

Table 4: Occupational Exposure Scenario Descriptions for the Use of Atrazine (continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions	Comments
Low Pressure Handwand - Liquid Formulation (LCO) (11)	PHED V1.1	5 acres (full) or **40 gal** 1 acre (spot treatment) [atrazine liquid labels require 40 gal/acre]	**Baseline:** Dermal (9 to 80 replicates) and inhalation (80 replicates) exposure values are based on ABC grade data. Hand (70 replicates) exposure value is based on all grade data. Low confidence in the dermal and hands unit exposure values. Medium confidence in the inhalation unit exposure value. No protection factors were needed to define the unit exposure value. **PPE:** The same dermal, inhalation, and hand data are used as for baseline coupled, if needed, with a 50% protection factor to account for the use of an additional layer of clothing and an 80% protection factor to account for the use of a dust/mist respirator. Gloved hand (10 replicates) exposure value is based on ABC grade data. Low confidence in gloved hand data. **Engineering Controls:** Not available for this assessment.
Lawn Handgun (and Compressed Air Sprayer) - Liquid Formulations (LCO) (12)	PHED V1.1	5 acres	This scenario represents combined data from scenarios 1d and 7.
	ORETF Study OMAA002	5 acres	Baseline: Dermal (15 replicates) and inhalation (15 replicates) data were used to establish exposure values. A 90% protection factor was used to back calculate a “no gloved” scenario using gloved hand (15 replicates) data. PPE: The same dermal and inhalation data are used as for baseline coupled, if needed, with a 50% protection factor to account for the use of an additional layer of clothing and an 80% protection factor to account for the use of a dust/mist respirator. Gloved hand (60 replicates) data were used to establish an exposure value. Engineering Controls: Not available for this scenario.
Loading and Applying Granulars with a Push Type Spreader (LCO) (13)	PHED V1.1	5 acres	**Baseline:** Dermal (0-15 replicates); and hand (55 replicates) exposure values based on C grade data. Inhalation (15 replicates) exposure value is based on B grade data. Low confidence in dermal/hand data and high confidence in the inhalation unit exposure values. No protection factors were needed to define the unit exposure values. **PPE:** The same dermal and inhalation data are used as for the baseline coupled, when needed, with a 50% protection factor to account for an additional layer of clothing and a 80% protection factor to account for the use of a dust/mist respirator. Gloved-hand (0 replicates) exposure value is low confidence due to lack of gloved hand data. **Engineering Controls:** Not available for this scenario.

Table 4: Occupational Exposure Scenario Descriptions for the Use of Atrazine (continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions	Comments
	ORETF Study OMA001	5 acres	**Baseline**: Hand (20 ungloved replicates), dermal (40 replicates) and inhalation (40 replicates) data were used to establish unit exposure values. **PPE**: The same dermal and inhalation data are used as for the baseline coupled, when needed, with a 50% protection factor to account for an additional layer of clothing and a 80% protection factor to account for the use of a dust/mist respirator. Gloved-hand (20 replicates) data used to establish exposure value. **Engineering Controls**: Not available for this scenario.
Granulars with a Bellygrinder (LCO) (14)	PHED V1.1	1 acre for spot treatments to turf	**Baseline:** Dermal (29-45 replicates); hand (23 replicates) exposure values based on ABC grade data. Inhalation (40 replicates) exposure value is based on AB grade data. Medium confidence in dermal/hand data and high confidence in the inhalation unit exposure value. No protection factors were needed to define the unit exposure values. **PPE:** The same dermal and inhalation data are used as for the baseline coupled, when needed, with a 50% protection factor to account for an additional layer of clothing and a 80% protection factor to account for the use of a dust/mist respirator. Gloved-hand (20 replicates) exposure value is based on all grade data. Low confidence in gloved hand data. **Engineering Controls:** Not available for this scenario.
Occupational Flagger Exposure			

Table 4: Occupational Exposure Scenario Descriptions for the Use of Atrazine (continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions	Comments
Flagging Sprays (15)	PHED V1.1	350 acres (higher acreage uses mechanical or electronic flagging)	**Baseline:** Dermal (18 to 28 replicates); hand (30 replicates); and inhalation (28 replicates) exposure values are based on AB grade data. High confidence in the unit exposure values. No protection factors were needed to define the unit exposure value. **PPE:** The same dermal and inhalation data are used as for the baseline coupled, if needed, with a 50% protection factor to account for the use of an additional layer of clothing and an 80% protection factor to account for the use of a dust/mist respirator. Hand (6 replicates) exposure value is based on AB grade data (not used). Low confidence in the gloved hand unit exposure value. **Engineering Controls (enclosed cab):** Data is based on groundboom enclosed cab. Dermal (20 to 31 replicates); hand (16 replicates); and inhalation (16 replicates) exposure values are based on ABC grade data for dermal and hands and AB grade data for inhalation. Medium confidence for hands and dermal and high confidence for inhalation.

[a] Standard assumptions are based on the activities of a typical individual over a daily 8 hour interval. Occupational scenarios reflect what individuals could accomplish in an 8 hour workday.

[b] Data quality assessments are based on the PHED grading criteria and the guidance provided in the Dec 1997 surrogate exposure table. Acceptable grades are matrices with grade A and/or B data. The PHED surrogate exposure table upon which this assessment is based was developed using the best data available in the system that are appropriate to the exposure scenario. Data confidence descriptors are assigned as follows:

High = grades A and B and 15 or more replicates;

Medium = grades A, B, and C and 15 or more replicates; and

Low = grades A, B, C, D, and E or any combination of grades with less than 15 replicates

Table 5: Occupational Short-term and Intermediate-term Handler Risks from Atrazine at Baseline

				Unit Exposure[c,d]		Short-Term Risks					Intermediate-Term Risks				
						Dose[e] (mg/kg/day)		MOEs[f]			Dose[e] (mg/kg/day)		MOEs[g]		
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre)	Amount Handled per Day[b] (acres)	Dermal (mg/lb ai)	Inhalation (µg/lb ai)	Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Mixer/Loader															
Mixing/Loading Liquid Formulations for Aerial Application (1a)	conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL	4	350	2.9	1.2	58	0.028	6.2	**360**	6	4.1	0.028	0.44	64	0.44
	sugarcane	2.6	350			38	0.018	9.5	**550**	9	2.6	0.018	0.68	99	0.68
	chemical fallow	3	1,200			150	0.072	2.4	**140**	2	10	0.072	0.17	25	0.17
			350			44	0.021	8.2	**480**	8	3.0	0.021	0.59	86	0.59
		1.4	1,200			70	0.034	5.1	**300**	5	4.9	0.034	0.37	54	0.37
			350			20	0.0098	18	**1,000**	17	1.4	0.0098	1.3	180	1.3
	CRP/grasslands	2	1,200			99	0.048	3.6	**210**	4	7.0	0.048	0.26	38	0.26
			350			29	0.014	12	**710**	12	2.0	0.014	0.89	130	0.88
	corn, sorghum	2	1,200			99	0.048	3.6	**210**	4	7.0	0.048	0.26	38	0.26
			350			29	0.014	12	**710**	12	2.0	0.014	0.89	130	0.88
		1	1,200			50	0.024	7.2	**420**	7	3.5	0.024	0.52	75	0.51
			350			15	0.0070	24	**1,400**	24	1.0	0.0070	1.8	260	1.8
	sod farms	2	350			29	0.014	12	**710**	12	2.0	0.014	0.89	130	0.88

Table 5: Occupational Short-term and Intermediate-term Handler Risks from Atrazine at Baseline (continued)

				Unit Exposure[c,d]		Short-Term Risks					Intermediate-Term Risks				
						Dose[e] (mg/kg/day)		MOEs[f]			Dose[e] (mg/kg/day)		MOEs[g]		
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre)	Amount Handled per Day[b] (acres)	Dermal (mg/lb ai)	Inhalation (µg/lb ai)	Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Mixing/Loading Liquid Formulations for Groundboom Application (1b)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	2.9	1.2	13	0.0064	27	**1,600**	27	0.93	0.0064	1.9	280	1.9
	sugarcane	2.6	80			8.6	0.0042	42	**2,400**	41	0.60	0.0042	3.0	430	3.0
	chemical fallow	3	450			56	0.027	6.4	**370**	6	3.9	0.027	0.46	67	0.46
			200			25	0.012	14	**830**	14	1.7	0.012	1.0	150	1.0
		1.4	450			26	0.013	14	**790**	14	1.8	0.013	0.99	140	0.98
			200			12	0.0056	31	**1,800**	31	0.81	0.0056	2.2	320	2.2
	CRP/grasslands	2	450			37	0.018	9.7	**560**	9	2.6	0.018	0.69	100	0.68
			200			17	0.0080	22	**1,300**	21	1.2	0.0080	1.6	230	1.5
	corn, sorghum	2	450			37	0.018	9.7	**560**	9	2.6	0.018	0.69	100	0.68
			200			17	0.0080	22	**1,300**	21	1.2	0.0080	1.6	230	1.5
		1	450			19	0.0090	19	**1,100**	19	1.3	0.0090	1.4	200	1.4
			200			8.3	0.0040	43	**2,500**	43	0.58	0.0040	3.1	450	3.1
	roadsides	1	40			1.7	0.00080	**220**	**13,000**	210	0.12	0.00080	16	2,300	15
	Bermuda grass rights-of-way	4	40			6.6	0.0032	54	**3,100**	53	0.46	0.0032	3.9	560	3.9
	golf course turf	2	40			3.3	0.0016	**110**	**6,300**	110	0.23	0.0016	7.8	1100	7.7
	sod farms	2	80			6.6	0.0032	54	**3,100**	53	0.46	0.0032	3.9	560	3.9
Mixing/Loading Liquid Formulations for Rights-of-Way Sprayer (1c)	roadsides	1	40	2.9	1.2	1.7	0.00080	**220**	**13,000**	210	0.12	0.0080	16	2300	15
	bermuda grass rights-of-way	4	40			6.6	0.0032	54	**3,100**	53	0.46	0.0032	3.9	560	3.9

Table 5: Occupational Short-term and Intermediate-term Handler Risks from Atrazine at Baseline (continued)

				Unit Exposure[c,d]		Short-Term Risks					Intermediate-Term Risks				
						Dose[e] (mg/kg/day)		MOEs[f]			Dose[e] (mg/kg/day)		MOEs[g]		
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre)	Amount Handled per Day[b] (acres)	Dermal (mg/lb ai)	Inhalation (µg/lb ai)	Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Mixing/Loading Liquid Formulations for Lawn Handgun Application (LCO) (1d)	lawns, golf courses	2	100	2.9	1.2	8.3	0.0040	43	**2,500**	43	0.58	0.0040	3.1	450	3.1
Mixing/Loading/ Incorporating Liquid Formulations onto Dry Bulk Fertilizer (1e)	commercial fertilizer for corn, sorghum	2	NA 700 lb fert/day	2.9	1.2	See Engineering Controls									
			NA 400 lb fert/day			See Engineering Controls									
			NA 200 lb fert/day			See Engineering Controls									
	commercial fertilizer for corn, sorghum	1	NA 700 lb fert/day			See Engineering Controls									
			NA 400 lb fert/day			See Engineering Controls									
			NA 200 lb fert/day			See Engineering Controls									
	on-farm fertilizer for corn, sorghum	2	500			41	0.02	8.7	**500**	8.5	2.9	0.02	0.62	90	0.62
			250			21	0.01	17	**1,000**	17	1.5	0.01	1.2	180	1.2
			143			12	0.0057	30	**1,700**	30	0.83	0.0057	2.2	310	2.2
		1	500			21	0.01	17	**1,000**	17	1.5	0.01	1.2	180	1.2
			250			10	0.005	35	**2,000**	34	0.73	0.005	2.4	360	2.4
			143			5.9	0.0029	61	**3,500**	60	0.41	0.0029	4.3	630	4.3

Table 5: Occupational Short-term and Intermediate-term Handler Risks from Atrazine at Baseline (continued)

				Unit Exposure[c,d]		Short-Term Risks					Intermediate-Term Risks				
						Dose[e] (mg/kg/day)		MOEs[f]			Dose[e] (mg/kg/day)		MOEs[g]		
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre)	Amount Handled per Day[b] (acres)	Dermal (mg/lb ai)	Inhalation (µg/lb ai)	Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Mixing/Loading Liquid Formulations into Liquid Bulk Fertilizer at Commercial Operations (1f)	fertilizer for corn, sorghum	2	UNK	2.9	1.2	No Data									
			UNK			No Data									
			UNK			No Data									
		1	UNK			No Data									
			UNK			No Data									
			UNK			No Data									
Mixing/Loading Dry Flowable (Water Dispersible Granule) for Aerial (2a)	conifer forests	4	1,200	0.066	0.77	4.5	0.062	80	**160**	53	0.32	0.062	5.7	29	4.8
			350	0.066	0.77	1.3	0.018	**270**	**560**	180	0.092	0.018	19	100	16
	sugarcane, conifer (Christmas tree) farms, turf for sod in FL	4	350	0.066	0.77	1.3	0.018	**270**	**560**	180	0.092	0.018	19	100	16
	sugarcane	2.6	350	0.066	0.77	0.86	0.012	**420**	**860**	280	0.06	0.012	30	150	25
	chemical fallow	3	1,200	0.066	0.77	3.4	0.046	**110**	**220**	71	0.24	0.046	7.6	39	6.3
			350	0.066	0.77	0.99	0.013	**360**	**740**	240	0.069	0.013	26	130	22
		1.4	1,200	0.066	0.77	1.6	0.022	**230**	**460**	150	0.11	0.022	16	83	14
			350	0.066	0.77	0.46	0.0063	**780**	**1,600**	520	0.032	0.0063	56	290	47
	CRP/grasslands	2	1,200	0.066	0.77	2.3	0.031	**160**	**320**	110	0.16	0.031	11	58	9.5
			350	0.066	0.77	0.66	0.009	**550**	**1,100**	370	0.046	0.009	39	200	33
	corn, sorghum	2	1,200	0.066	0.77	2.3	0.031	**160**	**320**	110	0.16	0.031	11	58	9.5
			350	0.066	0.77	0.66	0.009	**550**	**1,100**	370	0.046	0.009	39	200	33
		1	1,200	0.066	0.77	1.1	0.015	**320**	**650**	210	0.079	0.015	23	120	19
			350	0.066	0.77	0.33	0.0045	**1,100**	**2,200**	730	0.023	0.005	78	400	65
	sod farms	2	350	0.066	0.77	0.66	0.009	**550**	**1,100**	370	0.046	0.009	39	200	33

Table 5: Occupational Short-term and Intermediate-term Handler Risks from Atrazine at Baseline (continued)

				Unit Exposure[c,d]		Short-Term Risks					Intermediate-Term Risks				
						Dose[e] (mg/kg/day)		MOEs[f]			Dose[e] (mg/kg/day)		MOEs[g]		
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre)	Amount Handled per Day[b] (acres)	Dermal (mg/lb ai)	Inhalation (µg/lb ai)	Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Mixing/Loading Dry Flowables (water dispersible) for Groundboom Application (2b)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	0.066	0.77	0.30	0.0041	**1,200**	**2,400**	800	0.021	0.0041	85	440	71
	sugarcane	2.6	80			0.20	0.0027	**1,800**	**3,700**	1200	0.014	0.0027	130	670	**110**
	chemical fallow	3	450			1.3	0.017	**280**	**580**	190	0.089	0.017	20	100	17
			200			0.57	0.0077	**640**	**1,300**	430	0.04	0.0077	45	230	38
		1.4	450			0.59	0.0081	**610**	**1,200**	410	0.042	0.0081	43	220	36
			200			0.26	0.0036	**1,400**	**2,800**	920	0.018	0.0036	97	500	82
	CRP/grasslands	2	450			0.85	0.012	**420**	**830**	280	0.059	0.012	30	160	25
			200			0.38	0.0051	**950**	**1,900**	640	0.026	0.0051	68	350	57
	corn, sorghum	2	450			0.85	0.012	**420**	**830**	280	0.059	0.012	30	160	25
			200			0.38	0.0051	**950**	**1,900**	640	0.026	0.0051	68	350	57
		1	450			0.42	0.0058	**850**	**1,700**	570	0.03	0.0058	61	310	51
			200			0.19	0.0026	**1,900**	**3,900**	1300	0.013	0.0026	140	700	**110**
	roadsides	1	40			0.038	0.00051	**9,500**	**19,000**	6400	0.0026	0.00051	680	3,500	**570**
	Bermuda grass hwy rights- of- way	4	40			0.15	0.0021	**2,400**	**4,900**	1600	0.011	0.0021	170	880	**140**
	golf course turf	2	40			0.075	0.001	**4,800**	**9,700**	3200	0.0053	0.001	340	1,800	**290**
	sod farms	2	80			0.15	0.0021	**2,400**	**4,900**	1600	0.011	0.0021	170	880	**140**
Mixing/Loading Dry Flowables (water dispersible) for Rights of Way (2c)	roadsides	1	40	0.066	0.77	0.038	0.00051	**9,500**	**19,000**	6400	0.0026	0.00051	680	3,500	**570**
	Bermuda grass hwy rights- of- way	4	40			0.15	0.0021	**2,400**	**4,900**	1600	0.011	0.0021	170	880	**140**
Loading Granular Formulations (3)	sod farms	2	80	0.0084	1.7	0.019	0.0045	**19,000**	**2,200**	2000	0.0013	0.0045	1,300	400	**310**
	golf course turf	2	40			0.0096	0.0023	**38,000**	**4,400**	3900	0.00067	0.0023	2,700	790	**610**

Table 5: Occupational Short-term and Intermediate-term Handler Risks from Atrazine at Baseline (continued)

				Unit Exposure[c,d]		Short-Term Risks					Intermediate-Term Risks				
						Dose[e] (mg/kg/day)		MOEs[f]			Dose[e] (mg/kg/day)		MOEs[g]		
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre)	Amount Handled per Day[b] (acres)	Dermal (mg/lb ai)	Inhalation (µg/lb ai)	Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Applicator															
Applying Liquids with Aircraft (4)	sugarcane, conifer (Christmas tree) farms, sod farms in FL	4	350	See Engineering Controls											
	sugarcane	2.6	350	See Engineering Controls											
	chemical fallow	3	1,200	See Engineering Controls											
			350	See Engineering Controls											
		1.4	1,200	See Engineering Controls											
			350	See Engineering Controls											
	CRP/grasslands	2	1,200	See Engineering Controls											
			350	See Engineering Controls											
	corn, sorghum	2	1,200	See Engineering Controls											
			350	See Engineering Controls											
		1	1,200	See Engineering Controls											
			350	See Engineering Controls											
	sod farms	2	350	See Engineering Controls											
Applying Liquids for Groundboom Application (5)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	0.014	0.74	0.064	0.0039	**5,600**	**2,500**	1700	0.0045	0.0039	400	460	**210**
	sugarcane	2.6	80			0.042	0.0026	**8,700**	**3,900**	2700	0.0029	0.0026	620	690	**330**
	chemical fallow	3	450			0.27	0.017	**1,300**	**600**	410	0.019	0.017	95	110	51
			200			0.12	0.0074	**3,000**	**1,400**	930	0.0084	0.0074	210	240	**110**
		1.4	450			0.13	0.0078	**2,900**	**1,300**	890	0.0088	0.0078	200	230	**110**
			200			0.056	0.0034	**6,400**	**2,900**	2000	0.0039	0.0035	460	520	**240**
	CRP/grasslands	2	450			0.18	0.011	**2,000**	**900**	620	0.013	0.011	140	160	76
			200			0.08	0.0049	**4,500**	**2,000**	1400	0.0056	0.0049	320	360	**170**
	corn, sorghum	2	450			0.18	0.011	**2,000**	**900**	620	0.013	0.011	140	160	76
			200			0.08	0.0049	**4,500**	**2,000**	1400	0.0056	0.0049	320	360	**170**
		1	450			0.09	0.0056	**4,000**	**1,800**	1200	0.0063	0.0056	290	320	**150**

Table 5: Occupational Short-term and Intermediate-term Handler Risks from Atrazine at Baseline (continued)

				Unit Exposure[c,d]		Short-Term Risks					Intermediate-Term Risks				
						Dose[e] (mg/kg/day)		MOEs[f]			Dose[e] (mg/kg/day)		MOEs[g]		
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre)	Amount Handled per Day[b] (acres)	Dermal (mg/lb ai)	Inhalation (µg/lb ai)	Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
			200			0.04	0.0025	**9,000**	**4,100**	2800	0.0028	0.0025	640	730	**340**
	Bermuda grass hwy rights-of-way	4	40			0.032	0.002	**11,000**	**5,100**	3500	0.0022	0.002	800	910	**430**
	roadsides	1	40			0.008	0.00049	**45,000**	**20,000**	14000	0.00056	0.00049	3,200	3,600	**1,700**
	golf course turf	2	40			0.016	0.00099	**23,000**	**10,000**	7000	0.0011	0.00099	1,600	1,800	**850**
	sod farms	2	80			0.032	0.002	**11,000**	**5,100**	3500	0.0022	0.002	800	910	**430**
Applying Liquids with a Rights-of-Way Sprayer (6)	Bermuda grass hwy rights-of-way	4	40	1.3	3.9	3	0.01	**120**	**960**	110	0.21	0.01	8.7	170	8.2
	Roadsides	1				0.74	0.0026	**480**	**3,800**	430	0.052	0.0026	35	690	33
Applying Liquids with a Handgun (7)	lawns, golf courses	2	5	see PPE	1.4	see PPE	0.00023	see PPE	**43,000**	NA	see PPE	0.00023	see PPE	7,700	none, see PPE

Table 5: Occupational Short-term and Intermediate-term Handler Risks from Atrazine at Baseline (continued)

				Unit Exposure[c,d]		Short-Term Risks					Intermediate-Term Risks				
						Dose[e] (mg/kg/day)		MOEs[f]			Dose[e] (mg/kg/day)		MOEs[g]		
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre)	Amount Handled per Day[b] (acres)	Dermal (mg/lb ai)	Inhalation (µg/lb ai)	Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Applying Impregnated Dry Bulk Granular Fertilizer with Tractor Drawn Spreader(8)	corn, sorghum	2	500	0.0099	1.2	0.14	0.02	**2,500**	**500**	420	0.0099	0.02	180	90	60
			250			0.071	0.01	**5,100**	**1,000**	840	0.005	0.01	360	180	**120**
			143			0.040	0.0057	**8,900**	**1,700**	1500	0.0028	0.0057	640	310	**210**
		1	500			0.071	0.01	**5,100**	**1,000**	840	0.005	0.01	360	180	**120**
			250			0.035	0.005	**10,000**	**2,000**	1700	0.0025	0.005	730	360	**240**
			143			0.02	0.0029	**18,000**	**3,500**	2900	0.0014	0.0029	1,300	630	**420**
Applying Granular with a Tractor Drawn Spreader (9)	on farm fertilizer for corn, sorghum	2	200	0.0099	1.2	0.057	0.008	**6,400**	**1,300**	1000	0.004	0.008	450	230	**150**
			80			0.023	0.0032	**16,000**	**3,100**	2600	0.0016	0.0032	1,100	560	**380**
		1	200			0.028	0.004	**13,000**	**2,500**	2100	0.002	0.004	910	450	**300**
			80			0.011	0.0016	**32,000**	**6,300**	5200	0.00079	0.0016	2,300	1,100	**750**
	golf course turf	2	40			0.011	0.0016	**32,000**	**6,300**	5200	0.00079	0.0016	2,300	1,100	**750**
Mixer/Loader/Applicator															
Backpack Sprayer: Liquid Formulations (LCO) (10)	lawns, golf courses	2	5	See PPE	30	see PPE	0.001	see PPE	**10,000**	NA	see PPE	0.001	see PPE	1800	none, see PPE
Low Pressure Handwand - Liquid Formulations (LCO) (11)	lawns, golf courses	2	1 (40 gal)	100	30	2.9	0.001	130	**10,000**	130	1	0.001	9	1800	9
Lawn Handgun (and Compressed Air Sprayer) (liquid formulations) (LCO) (12)	lawns, golf courses	2	1 (40 gal)	see PPE	2.6	See PPE	0.00043	see PPE	**23,000**	NA	see PPE	0.00043	see PPE	4,200	none, see PPE
Granulars with a Push Type Spreader (LCO) (13)	lawns, golf courses	2	5	2.9	6.3	0.41	0.0011	**8100**	**9,500**	4400	0.029	0.0011	62	1,700	60
Granulars with a Bellygrinder (LCO) (14)	lawns, golf courses	2	1	10	62	0.29	0.0021	**1,300**	**4,800**	1000	0.02	0.0021	90	870	82

Table 5: Occupational Short-term and Intermediate-term Handler Risks from Atrazine at Baseline (continued)

				Unit Exposure[c,d]		Short-Term Risks					Intermediate-Term Risks				
						Dose[e] (mg/kg/day)		MOEs[f]			Dose[e] (mg/kg/day)		MOEs[g]		
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre)	Amount Handled per Day[b] (acres)	Dermal (mg/lb ai)	Inhalation (µg/lb ai)	Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Flagging															
Flagging Aerial Sprays (15)	conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms	4	350	0.011	0.35	0.22	0.0082	**1,600**	**1,200**	700	0.015	0.0082	120	220	76
	sugarcane	2.6	350			0.14	0.0053	**2,500**	**1,900**	1100	0.01	0.0053	180	340	**120**
	chemical fallow	3	1,200			0.57	0.021	**640**	**480**	270	0.04	0.021	45	86	30
			350			0.17	0.0061	**2,200**	**1,600**	930	0.012	0.0061	160	290	**100**
		1.4	1,200			0.26	0.0098	**1,400**	**1,000**	580	0.018	0.0098	97	180	64
			350			0.077	0.0029	**4,700**	**3,500**	2000	0.0054	0.0029	330	630	**220**
	CRP/grasslands	2	1,200			0.38	0.014	**950**	**710**	410	0.026	0.014	68	130	45
			350			0.11	0.0041	**3,300**	**2,400**	1400	0.0077	0.0041	230	440	**150**
	corn, sorghum	2	1,200			0.38	0.014	**950**	**710**	410	0.026	0.014	68	130	45
			350			0.11	0.0041	**3,300**	**2,400**	1400	0.0077	0.0041	230	440	**150**
		1	1,200			0.19	0.007	**1,900**	**1,400**	820	0.013	0.007	140	260	89
			350			0.055	0.002	**6,500**	**4,900**	2800	0.0039	0.002	470	880	**310**
	sod farms	2	350			0.11	0.0041	**3,300**	**2,400**	1400	0.0077	0.0041	230	440	**150**

Footnotes:

a Application rates represent maximum rates determined from EPA registered labels for atrazine. Typical use rates as determined by BEAD were assessed for corn and sorghum (1.0 lb ai/acre), sugarcane (2.6 lb ai/acre) and chemical fallow (1.4 lb ai/acre).

b Amount handled per day based on Exposure SAC Policy # 9 "Standard Values for Daily Acres Treated In Agriculture," Revised June 23, 2000.

c Baseline dermal unit exposure represents long pants, long sleeved shirt, no gloves, open mixing/loading, open cab/tractor. Values from PHED Surrogate Exposure Guide - August, 1998.

d Baseline inhalation unit exposure represents no respirator. PHED Surrogate Exposure Guide - August 1998.

e Dermal daily dose (mg/kg/day) = daily unit exposure (mg/lb ai) x application rate (lb ai/acre) x area treated per day (acres/day) / body weight (70 kg adults for short-term and 60 kg adult female --developmental effect -- for intermediate-term assessment). For intermediate-term dermal dose an absorption factor of 6 percent applies.
Inhalation daily dose (mg/kg/day) = inhalation unit exposure (µg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) x conversion factor (1 mg/1,000 µg) / body weight (60 kg developmental female for both short-term and intermediate-term assessment).

f Short-term dermal MOE = NOAEL (360 mg/kg/day based on a dermal rat study) / daily dose (mg/kg/day).
Short-term inhalation MOE = NOAEL (10 mg/kg/day) / daily dose (mg/kg/day).

g Intermediate-term dermal MOE = NOAEL (1.8 mg/kg/day based on an oral developmental study) / daily dose (mg/kg/day).

h Intermediate-term inhalation MOE = NOAEL (1.8 mg/kg/day) / daily dose (mg/kg/day). .
Aggregate MOE = NOAEL (1.8 mg/kg/day) / absorbed daily dermal + inhalation dose (mg/kg/day)

See PPE = no data at baseline, see exposures and risks with personal protective equipment

See Engineering Controls = no data at baseline or PPE, see exposures and risks with engineering controls

CRP = Conservation Reserve Program

Table 6: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Mitigation

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	PPE Unit Exposures		Short-Term Risks with PPE Mitigation					Intermediate-Term Risks with PPE Mitigation						
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)			MOEs[g]			
				Unit Exposure Dermal[c] (mg/lb ai) (g=gloves; dl=double layer body protection)	Inhalation[d] (µg/lb ai) with dust/mist respirator (80%PF)	Dermal with gloves, unless noted	Inhalation with dust/mist respirator	Dermal with gloves unless noted	Inhal-ation with dust /mist respirat or (NN at all scenario s)	Aggr e-gate	Dermal with gloves	Dermal with gloves + double layers	Inhalatio n with dust/mist respirator	Dermal with gloves	Dermal with gloves + double layers	Inhalatio n with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted
Mixer/Loader																	
Mixing/Loading Liquid Formulations for Aerial Application (1a)	conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL	4	350	0.023 g .017 g, dl	0.24	0.46	0.0056	**780**	1,800	540	0.032	0.024	0.0056	56	76	320	61
	sugarcane	2.6	350			0.3	0.0036	**1,200**	2,700	840	0.021	0.015	0.0036	86	120	490	94
	chemical fallow	3	1,200			1.2	0.014	**300**	690	210	0.083	0.061	0.014	22	29	130	24
			350			0.35	0.0042	**1,000**	2,400	730	0.024	0.018	0.0042	75	100	430	82
		1.4	1,200			0.55	0.0067	**650**	1,500	450	0.039	0.029	0.0067	47	63	270	51 g,dl
			350			0.16	0.002	**2,200**	5,100	1600	0.011	0.0083	0.002	160	220	920	**99 g,dl**
	CRP and grasslands	2	1,200			0.79	0.0096	**460**	1,000	320	0.055	0.041	0.0096	33	44	190	36
			350			0.23	0.0028	**1,600**	3,600	1100	0.016	0.012	0.0028	110	150	640	**120**
	corn, sorghum	2	1,200			0.79	0.0096	**460**	1,000	320	0.055	0.041	0.0096	33	44	190	36
			350			0.23	0.0028	**1,600**	3,600	1100	0.016	0.012	0.0028	110	150	640	**120**
		1	1,200			0.39	0.0048	**910**	2,100	630	0.028	0.02	0.0048	65	88	380	71
			350			0.12	0.0014	**3,100**	7,100	2200	0.0081	0.006	0.0014	220	300	1,300	**120 g**
	sod farms	2	350			0.23	0.0028	**1,600**	3,600	1100	0.016	0.012	0.0028	110	150	640	**120**

Table 6: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Mitigation (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	PPE Unit Exposures		Short-Term Risks with PPE Mitigation					Intermediate-Term Risks with PPE Mitigation						
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)			MOEs[g]			
				Unit Exposure Dermal[c] (mg/lb ai) (g=gloves; dl=double layer body protection)	Inhalation[d] (µg/lb ai) with dust/mist respirator (80%PF)	Dermal with gloves, unless noted	Inhalation with dust/mist respirator	Dermal with gloves unless noted	Inhal-ation with dust /mist respirator (NN at all scenarios)	Aggre-gate	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted
Mixing/Loading Liquid Formulations for Groundboom Application (1b)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	0.023 g 0.017 g,dl	0.24	0.11	0.0013	**3,400**	7,800	2400	0.0074	0.0054	0.0013	240	330	1,400	**130 g**
	sugarcane	2.6	80			0.068	0.00083	**5,300**	12,000	3700	0.0048	0.0035	0.0008	380	510	2,200	**200 g**
	chemical fallow	3	450			0.44	0.0054	**810**	1,900	560	0.031	0.023	0.0054	58	78	330	63
			200			0.2	0.0024	**1,800**	4,200	1300	0.014	0.01	0.0024	130	180	750	**110 g,r**
		1.4	450			0.21	0.0025	**1,700**	4,000	1200	0.014	0.011	0.0025	120	170	710	**110 g,r**
			200			0.092	0.0011	**3,900**	8,900	2700	0.0064	0.0048	0.0011	280	380	1,600	**150 g**
	CRP/grasslands	2	450			0.3	0.0036	**1,200**	2,800	850	0.021	0.015	0.0036	87	120	500	95
			200			0.13	0.0016	**2,700**	6,300	1900	0.0092	0.0068	0.0016	200	260	1,100	**100 g**
	corn, sorghum	2	450			0.3	0.0036	**1,200**	2,800	850	0.021	0.015	0.0036	87	120	500	95
			200			0.13	0.0016	**2,700**	6,300	1900	0.0092	0.0068	0.0016	200	260	1,100	**100 g**
		1	450			0.15	0.0018	**2,400**	5,600	1700	0.01	0.0077	0.0018	170	240	1,000	**110 g,dl**
			200			0.066	0.0008	**5,500**	13,000	3800	0.0046	0.0034	0.0008	390	530	2,300	**210 g**
	roadsides	1	40			0.013	0.00016	27,000 (NN)	63,000	19000	0.00092	0.00068	0.0002	2000	2600	11,000	**1,000 g**
	Bermuda grass hwy rights-of-way	4	40			0.053	0.00064	**6,800**	16,000	4800	0.0037	0.0027	0.0006	490	660	2,800	**260 g**
	golf course turf	2	40			0.026	0.00032	14,000 (NN)	31,000	9500	0.0018	0.0014	0.0003	980	1300	5,600	**520 g**
	sod farms	2	80			0.053	0.00064	**6,800**	16,000	4800	0.0037	0.0027	0.0006	490	660	2,800	**260 g**
Mixing/Loading Liquid Formulations for Rights-of-Way Sprayer (1c)	roadsides	1	40			0.013	0.00016	27,000 (NN)	63,000	19000	0.00092	0.00068	0.0002	2000	2600	11,000	**1,000 g**
	Bermuda grass hwy rights of way	4	40			0.053	0.00064	**6,800**	16,000	4800	0.0037	0.0027	0.0006	490	660	2,800	**260 g**

Table 6: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Mitigation (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	PPE Unit Exposures		Short-Term Risks with PPE Mitigation					Intermediate-Term Risks with PPE Mitigation						
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)			MOEs[g]			
				Unit Exposure Dermal[c] (mg/lb ai) (g=gloves; dl=double layer body protection)	Inhalation[d] (µg/lb ai) with dust/mist respirator (80%PF)	Dermal with gloves, unless noted	Inhalation with dust/mist respirator	Dermal with gloves unless noted	Inhal-ation with dust /mist respirator (NN at all scenarios)	Aggre-gate	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted
Mixing/Loading Liquid Formulations for Lawn Handgun Application (LCO) (1d)	lawns, golf courses	2	100			0.066	0.0008	**5,500**	13,000	3800	0.0046	0.0034	0.0008	390	530	2,300	**210 g**
Mixing/Loading/ Incorporating Liquid Formulations onto Dry Bulk Fertilizer (1e)	commercial fertilizer for corn, sorghum	2	NA 700 lbs fert/day	0.023	0.24	See Engineering Controls											
			NA 400 lbs fert/day			See Engineering Controls											
			NA 200 lbs fert/day			See Engineering Controls											
		1	NA 700 lbs fert/day			See Engineering Controls											
			NA 400 lbs fert/day			See Engineering Controls											
			NA 200 lbs fert/day			See Engineering Controls											
		2	500			0.33	0.004	**1,100**	2,500	760	0.023	0.017	0.004	78	110	450	86
			250			0.16	0.002	**2,200**	5,000	1500	0.012	0.0085	0.002	160	210	900	**97 g,dl**
			143			0.094	0.0011	**3,800**	8,700	2700	0.0066	0.0049	0.0011	270	370	1,600	**150 g**
		1	500			0.16	0.002	**2,200**	5,000	1500	0.012	0.0085	0.002	160	210	900	**97 g,dl**
			250			0.082	0.001	**4,400**	10,000	3000	0.0058	0.0043	0.001	310	420	1,800	**170 g**
			143			0.047	0.00057	**7,700**	17,000	5300	0.0033	0.0024	0.0006	550	740	3,100	**290 g**

Table 6: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Mitigation (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	PPE Unit Exposures		Short-Term Risks with PPE Mitigation					Intermediate-Term Risks with PPE Mitigation						
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)			MOEs[g]			
				Unit Exposure Dermal[c] (mg/lb ai) (g=gloves; dl=double layer body protection)	Inhalation[d] (µg/lb ai) with dust/mist respirator (80%PF)	Dermal with gloves, unless noted	Inhalation with dust/mist respirator	Dermal with gloves unless noted	Inhal-ation with dust /mist respirator (NN at all scenarios)	Aggre-gate	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted
Mixing/Loading Liquid Formulations into Liquid Bulk Fertilizer at Commercial Operations (1f)	fertilizer for corn, sorghum	2	UNK	No Data													
			UNK	No Data													
			UNK	No Data													
		1	UNK	No Data													
			UNK	No Data													
			UNK	No Data													
Mixing/Loading Dry Flowable (Water Dispersible Granule) for Aerial (2a)	conifer forests	4	1,200	0.066 g 0.047 g,dl	0.154	4.5	0.012	**110 g,dl**	810	72	0.32	0.23	0.012	5.7	8	150	8
			350	0.066	0.154	1.3	0.0036	270 (NN)	2,800	250	0.092	0.066	0.0036	19	27	500	26
	sugarcane, conifer (Christmas tree) farms, turf for sod in FL	4	350	0.066	0.154	1.3	0.0036	270 (NN)	2,800	250	0.092	0.066	0.0036	19	27	500	26
	sugarcane	2.6	350	0.066	0.154	0.86	0.0023	420 (NN)	4,300	380	0.06	0.043	0.0023	30	42	770	40
	chemical fallow	3	1,200	0.066	0.154	3.4	0.0092	110 (NN)	1,100	97	0.24	0.17	0.0092	7.6	11	190	10
		3	350	0.066	0.154	0.99	0.0027	360 (NN)	3,700	330	0.069	0.049	0.0027	26	36	670	35
		1.4	1,200	0.066	0.154	1.6	0.0043	230 (NN)	2,300	210	0.11	0.079	0.0043	16	23	420	22
		1.4	350	0.066	0.154	0.46	0.0013	780 (NN)	8,000	710	0.032	0.023	0.0013	56	78	1,400	61 g,dl
	CRP or grasslands	2	1,200	0.066	0.154	2.3	0.0062	160 (NN)	1,600	140	0.16	0.11	0.0062	11	16	290	15
			350	0.066	0.154	0.66	0.0018	550 (NN)	5,600	500	0.046	0.033	0.0018	39	55	1,000	43 g,dl
	corn, sorghum	2	1,200	0.066	0.154	2.3	0.0062	160 (NN)	1,600	140	0.16	0.11	0.0062	11	16	290	15
			350	0.066	0.154	0.66	0.0018	550 (NN)	5,600	500	0.046	0.033	0.0018	39	55	1,000	43 g,dl
		1	1,200	0.066	0.154	1.1	0.0031	320 (NN)	3,200	290	0.079	0.056	0.0031	23	32	580	30
			350	0.066	0.154	0.33	0.0009	1,100 (NN)	11,000	990	0.023	0.016	0.0009	78	110	2,000	86 g,dl
	sod farms	2	350	0.066	0.154	0.66	0.0018	550 (NN)	5,600	500	0.046	0.033	0.0018	39	55	1,000	43 g,dl

Table 6: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Mitigation (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	PPE Unit Exposures		Short-Term Risks with PPE Mitigation					Intermediate-Term Risks with PPE Mitigation						
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)			MOEs[g]			
				Unit Exposure Dermal[c] (mg/lb ai) (g=gloves; dl=double layer body protection)	Inhalation[d] (µg/lb ai) with dust/mist respirator (80%PF)	Dermal with gloves, unless noted	Inhalation with dust/mist respirator	Dermal with gloves unless noted	Inhal-ation with dust /mist respirator (NN at all scenarios)	Aggre-gate	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted
Mixing/Loading Dry Flowables (water dispersible) for Groundboom Application (2b)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	0.066	0.154	0.3	0.00082	1,200 (NN)	12,000	1100	0.021	0.015	0.0008	85	120	2,200	94 g,dl
	sugarcane	2.6	80	0.066	0.154	0.2	0.00053	1,800 (NN)	19,000	1700	0.014	0.0098	0.0005	130	180	3,400	110 g (NN)
	chemical fallow	3	450	0.066	0.154	1.3	0.0035	280 (NN)	2,900	260	0.089	0.063	0.0035	20	28	520	27
			200	0.066	0.154	0.57	0.0015	640 (NN)	6,500	580	0.04	0.028	0.0015	45	64	1,200	50 g,dl
		1.4	450	0.066	0.154	0.59	0.0016	610 (NN)	6,200	550	0.042	0.03	0.0016	43	61	1,100	48 g,dl
			200	0.066	0.154	0.26	0.00072	1,400 (NN)	14,000	1200	0.018	0.013	0.0007	97	140	2,500	**110 g,dl**
	CRP/grasslands	2	450	0.066	0.154	0.85	0.0023	420 (NN)	4,300	390	0.059	0.042	0.0023	30	43	780	40
			200	0.066	0.154	0.38	0.001	950 (NN)	9,700	870	0.026	0.019	0.001	68	96	1,800	75 g,dl
	corn, sorghum	2	450	0.066	0.154	0.85	0.0023	420 (NN)	4,300	390	0.059	0.042	0.0023	30	43	780	40
			200	0.066	0.154	0.38	0.001	950 (NN)	9,700	870	0.026	0.019	0.001	68	96	1,800	75 g,dl
		1	450	0.066	0.154	0.42	0.0012	850 (NN)	8,700	770	0.03	0.021	0.0012	61	85	1,600	67 g,dl
			200	0.066	0.154	0.19	0.00051	1,900 (NN)	19,000	1700	0.013	0.0094	0.0005	140	190	3,500	150 g,dl (NN)
	roadsides	1	40	0.066	0.154	0.038	0.0001	9,500 (NN)	97,000	8700	0.0026	0.0019	0.0001	680	960	18,000	570 g (NN)
	Bermuda grass hwy rights-of-ways	4	40	0.066	0.154	0.15	0.00041	2,400 (NN)	24,000	2200	0.011	0.0075	0.0004	170	240	4,400	140 g (NN)
	golf course turf	2	40	0.066	0.154	0.075	0.00021	4,800 (NN)	49,000	4300	0.0053	0.0038	0.0002	340	480	8,800	290 g (NN)
	sod farms	2	80	0.066	0.154	0.15	0.00041	2,400 (NN)	24,000	2200	0.011	0.0075	0.0004	170	240	4,400	140 g (NN)

Table 6: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Mitigation (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	PPE Unit Exposures		Short-Term Risks with PPE Mitigation					Intermediate-Term Risks with PPE Mitigation						
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)			MOEs[g]			
				Unit Exposure Dermal[c] (mg/lb ai) (g=gloves; dl=double layer body protection)	Inhalation[d] (µg/lb ai) with dust/mist respirator (80%PF)	Dermal with gloves, unless noted	Inhalation with dust/mist respirator	Dermal with gloves unless noted	Inhal-ation with dust /mist respirator (NN at all scenarios)	Aggre-gate	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted
Mixing/Loading Dry Flowables (water dispersible) for Rights of Way (2c)	roadsides	1	40	0.066 g 0.047 g,dl	0.154	0.038	0.0001	9,500 (NN)	97,000	8700	0.0026	0.0019	0.0001	680	960	18,000	570 g (NN)
	Bermuda grass rights-of-way	4				0.15	0.00041	2,400 (NN)	24,000	2200	0.011	0.0075	0.0004	170	240	4,400	140 g (NN)
Loading Granular Formulations (3)	sod farms	2	80	0.0069 g 0.0034 g, dl	0.34	0.016	0.00091	23,000 (NN)	11,000	7400	0.0011	0.00054	0.0009	1,600	3,300	2,000	320 g (NN)
	golf course turf		40	0.0069	0.34	0.0079	0.00045	46,000 (NN)	22,000	15000	0.00055	0.00027	0.0005	3,300	6,600	4,000	640 g (NN)
Applicator																	
Applying Liquids with Aircraft (4)	conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL	4	350	See Engineering Controls													
	sugarcane	2.6	350	See Engineering Controls													
	chemical fallow	3	1,200	See Engineering Controls													
			350	See Engineering Controls													
		1.4	1,200	See Engineering Controls													
			350	See Engineering Controls													
	CRP or grasslands	2	1,200	See Engineering Controls													
			350	See Engineering Controls													
	corn, sorghum	2	1,200	See Engineering Controls													
			350	See Engineering Controls													
		1	1,200	See Engineering Controls													
			350	See Engineering Controls													
	sod farms	2	350	See Engineering Controls													

Table 6: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Mitigation (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	PPE Unit Exposures		Short-Term Risks with PPE Mitigation					Intermediate-Term Risks with PPE Mitigation						
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)			MOEs[g]			
				Unit Exposure Dermal[c] (mg/lb ai) (g=gloves; dl=double layer body protection)	Inhalation[d] (µg/lb ai) with dust/mist respirator (80%PF)	Dermal with gloves, unless noted	Inhalation with dust/mist respirator	Dermal with gloves unless noted	Inhal-ation with dust /mist respirator (NN at all scenarios)	Aggre-gate	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted
Applying Liquids for Groundboom Application (5)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	0.014 g, 0.011 g,dl	0.148	0.064	0.00079	5,600 (NN)	13,000	3900	0.0045	0.0035	0.0008	400	510	2,300	210 g (NN)
	sugarcane	2.6	80			0.042	0.00051	8,700 (NN)	19,000	6000	0.0029	0.0023	0.0005	620	790	3,500	330 g (NN)
	chemical fallow	3	450			0.27	0.0033	1,300 (NN)	3,000	920	0.019	0.015	0.0033	95	120	540	**99**
		3	200			0.12	0.0015	3,000 (NN)	6,800	2100	0.0084	0.0066	0.0015	210	270	1,200	110 g (NN)
		1.4	450			0.13	0.0016	2,900 (NN)	6,400	2000	0.0088	0.0069	0.0016	200	260	1,200	110 g (NN)
		1	200			0.04	0.00049	9,000 (NN)	20,000	4500	0.0039	0.0031	0.0007	460	580	2,600	240 g (NN)
	CRP or grasslands	1.4	450			0.13	0.0016	2,900 (NN)	6,400	1400	0.013	0.0099	0.0022	140	180	810	**120 g,r**
		2	200			0.08	0.00099	4,500 (NN)	10,000	3100	0.0056	0.0044	0.001	320	410	1,800	170 g (NN)
	corn, sorghum	2	450			0.18	0.0022	2,000 (NN)	4,500	1400	0.013	0.0099	0.0022	140	180	810	**120 g,r**
			200			0.08	0.00099	4,500 (NN)	10,000	3100	0.0056	0.0044	0.001	320	410	1,800	170 g (NN)
		1	450			0.09	0.0011	4,000 (NN)	9,000	2800	0.0063	0.005	0.0011	290	360	1,600	150 g (NN)
			200			0.04	0.00049	9,000 (NN)	20,000	6200	0.0028	0.0022	0.0005	640	820	3,600	340 g (NN)
	Bermuda grass hwy rights-of-way	4	40			0.032	0.00039	11,000 (NN)	25,000	7800	0.0022	0.0018	0.0004	800	1000	4,600	430 g (NN)
	roadsides	1	40			0.008	0.000099	45,000 (NN)	100,000	31000	0.00056	0.00044	0	3200	4100	18,000	1,700 g (NN)
	golf course turf	2	40			0.016	0.0002	23,000 (NN)	51,000	16000	0.0011	0.00088	0.0002	1600	2000	9,100	850 g (NN)

Table 6: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Mitigation (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	PPE Unit Exposures		Short-Term Risks with PPE Mitigation					Intermediate-Term Risks with PPE Mitigation						
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)			MOEs[g]			
				Unit Exposure Dermal[c] (mg/lb ai) (g=gloves; dl=double layer body protection)	Inhalation[d] (µg/lb ai) with dust/mist respirator (80%PF)	Dermal with gloves, unless noted	Inhalation with dust/mist respirator	Dermal with gloves unless noted	Inhal-ation with dust /mist respirator (NN at all scenarios)	Aggre-gate	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted
	sod farms	2	80			0.032	0.00039	11,000 (NN)	25,000	7800	0.0022	0.0018	0.0004	800	1,000	4,600	430 g (NN)
Applying Liquids with a Rights-of-Way Sprayer (6)	Bermuda grass hwy rights of way	4	40	0.39 g 0.29 g,dl	0.78	0.89	0.0021	400 (NN)	4,800	370	0.062	0.046	0.0021	29	39	870	37
	roadsides	1	40	0.39	0.78	0.22	0.00052	1,600 (NN)	19,000	1500	0.016	0.012	0.0005	120	160	3,500	**99 g**
Applying Liquids with a Handgun (7)	lawns, golf courses	2	5	0.34 g, 0.19 g,dl	0.28	0.049	0.000047	7,400 (NN)	210,000	7200	0.0034	0.0019	0	530	950	39,000	**500 g**
Applying Impregnated Dry Bulk Granular Fertilizer with Tractor Drawn Spreader(8)	corn, sorghum	2	500	0.0072 g 0.0042 g,dl	0.24	0.1	0.004	3,500 (NN)	2,500	1500	0.0072	0.0042	0.004	250	430	450	**160 g,r**
			250	0.0072	0.24	0.051	0.002	7,000 (NN)	5,000	2900	0.0036	0.0021	0.002	500	860	900	130 g (NN)
			143	0.0072	0.24	0.029	0.0011	12,000 (NN)	8,700	5100	0.0021	0.0012	0.0011	870	1,500	1,600	230 g (NN)
		1	500	0.0072	0.24	0.051	0.002	7,000 (NN)	5,000	2900	0.0036	0.0021	0.002	500	860	900	130 g (NN)
			250	0.0072	0.24	0.026	0.001	14,000 (NN)	10,000	5800	0.0018	0.0011	0.001	1000	1,700	1,800	260 g (NN)
			143	0.0072	0.24	0.015	0.00057	24,000 (NN)	17,000	10000	0.001	0.0006	0.0006	1700	3,000	3,100	460 g (NN)
Applying Granular with a Tractor Drawn Spreader (9)	on farm fertilizer for corn, sorghum?	2	200	0.0072	0.24	0.041	0.0016	8,800 (NN)	6,300	3600	0.0029	0.0017	0.0016	630	1,100	1,100	170 g (NN)
			80	0.0072	0.24	0.016	0.00064	22,000 (NN)	16,000	9100	0.0012	0.00067	0.0006	1600	2,700	2,800	410 g (NN)
		1	200	0.0072	0.24	0.021	0.0008	18,000 (NN)	13,000	7300	0.0014	0.00084	0.0008	1300	2,100	2,300	330 g (NN)
			80	0.0072	0.24	0.0082	0.00032	44,000 (NN)	31,000	18000	0.00058	0.00034	0.0003	3100	5,400	5,600	830 g (NN)
	golf course turf	2	40	0.0072	0.24	0.0082	0.00032	44,000 (NN)	31,000	18000	0.00058	0.00034	0.0003	3100	5,400	5,600	830 g (NN)

Table 6: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Mitigation (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	PPE Unit Exposures		Short-Term Risks with PPE Mitigation					Intermediate-Term Risks with PPE Mitigation						
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)			MOEs[g]			
				Unit Exposure Dermal[c] (mg/lb ai) (g=gloves; dl=double layer body protection)	Inhalation[d] (µg/lb ai) with dust/mist respirator (80%PF)	Dermal with gloves, unless noted	Inhalation with dust/mist respirator	Dermal with gloves unless noted	Inhal-ation with dust /mist respirator (NN at all scenarios)	Aggre-gate	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted
Mixer/Loader/Applicator																	
Backpack Sprayer - Liquid Formulations (LCO) (10)	lawns, golf courses	2	1 (40 gal)	2.5 g	6	0.071	0.0002	**5,000**	50,000	4500	0.01	0.0032	0.0002	360	560	9,000	**350 g**
Low Pressure Handwand - Liquid Formulations (LCO) (11)	lawns, golf courses	2	1 (40 gal)	0.43 g	6	0.012	0.0002	**2.9,000**	50,000	18,000	0.00086	0.00074	0.0002	2100	2,400	9,000	**1,700 g**
Lawn Handgun (and Compressed Air Sprayer) (LCO) (12)	lawns, golf courses	2	5	0.36 g 0.21 g,dl	0.52	0.051	0.000087	**7,000**	120,000	6600	0.0036	0.0021	0.0001	500	860	21,000	**450 g**
Granulars with a Push Type Spreader (LCO) (13)	lawns, golf courses	2	5	1.3 g 0.73 g,dl	1.3	0.19	0.00021	1,900 (NN)	48,000	1900	0.013	0.0073	0.0002	140	250	8,600	**130 g**
Granulars with a Bellygrinder (LCO) (14)	lawns, golf courses	2	1	9.3 g 5.7 g,dl	12	0.27	0.00041	1,400 (NN)	24,000	1300	0.02	0.011	0.00041	97	160	4,400	**95 g,r 130 g,dl**

Table 6: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Mitigation (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	PPE Unit Exposures		Short-Term Risks with PPE Mitigation					Intermediate-Term Risks with PPE Mitigation						
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)			MOEs[g]			
				Unit Exposure Dermal[c] (mg/lb ai) (g=gloves; dl=double layer body protection)	Inhalation[d] (µg/lb ai) with dust/mist respirator (80%PF)	Dermal with gloves, unless noted	Inhalation with dust/mist respirator	Dermal with gloves unless noted	Inhal-ation with dust /mist respirator (NN at all scenarios)	Aggre-gate	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Dermal with gloves	Dermal with gloves + double layers	Inhalation with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted
Flagging																	
Flagging Sprays (15)	conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms	4	350	NG 0.011 dl	0.07	0.2	0.0016	2,800 dl (NN)	6,100	1400	NG	0.014	0.0016	NG	130	1,100	81 dl
	sugarcane	2.6	350			0.13	0.0011	1,800 dl (NN)	9,400	2100	NG	0.01	0.0011	NG	200	1,700	120 dl (NN)
	chemical fallow	3	1,200			0.51	0.0042	700 dl (NN)	2,400	540	NG	0.036	0.0042	NG	50	430	45 dl,r
			350			0.15	0.0012	2,400 dl (NN)	8,200	1900	NG	0.011	0.0012	NG	170	1,500	110 dl (NN)
		1.4	1,200			0.24	0.002	1500 dl (NN)	5,100	1200	NG	0.017	0.002	NG	110	920	96 dl,r
			350			0.07	0.00057	5100 dl (NN)	17,000	4000	NG	0.0049	0.0006	NG	370	3,100	230 dl (NN)
	CRP or grasslands	2	1,200			0.34	0.0028	1100 dl (NN)	3,600	810	NG	0.024	0.0028	NG	75	640	67 dl,r
			350			0.1	0.00082	3600 dl (NN)	12,000	2800	NG	0.007	0.0008	NG	260	2,200	160 dl (NN)
	corn, sorghum	2	1,200			0.34	0.0028	1100 dl (NN)	3,600	810	NG	0.024	0.0028	NG	75	640	67 dl,r
			350			0.1	0.00082	3600 dl (NN)	12,000	2800	NG	0.007	0.0008	NG	260	2,200	160 dl (NN)
		1	1,200			0.17	0.0014	2100 dl (NN)	7,100	1600	NG	0.012	0.0014	NG	150	1,300	95 dl
			350			0.05	0.00041	7200 dl (NN)	24,000	5600	NG	0	0.0004	NG	510	4,400	320 dl (NN)
	sod farms	2	350			0.1	0.00082	3600 dl (NN)	12,000	2800	NG	0.007	0.0008	NG	260	2,200	160 dl (NN)

Table 6: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Mitigation (continued)

Footnotes:

a Application rates represent maximum rates determined from EPA registered labels for atrazine. Typical use rates as determined by BEAD were assessed for corn and sorghum (1.0 lb ai/acre), sugarcane (2.6 lb ai/acre) and chemical fallow (1.4 lb ai/acre).

b Amount handled per day based on Exposure SAC Policy # 9 "Standard Values for Daily Acres Treated In Agriculture," Revised June 23, 2000.

c PPE dermal unit exposure represents long pants, long sleeved shirt, plus gloves and/or double layer body protection (as indicated in table), and no engineering controls. Values from PHED Surrogate Exposure Guide - Draft August, 1998.

d PPE inhalation unit exposure represents a dust/mist respirator -- calculated using an 80%PF from baseline inhalation exposure values in PHED Surrogate Exposure Guide - August 1998.

e PPE dermal daily dose (mg/kg/day) = PPE daily unit exposure (mg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) / body weight (70 kg adult for short-term and 60 kg developmental female for intermediate-term assessment). For intermediate-term PPE dermal dose, an absorption factor of 6 percent applies.
PPE inhalation daily dose (mg/kg/day) = PPE inhalation unit exposure (µg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) x conversion factor (1 mg/1,000 µg) / body weight (60 kg developmental female for both short-term and intermediate-term assessment).

f Short-term PPE dermal MOE = NOAEL (360 mg/kg/day based on a dermal rat study) / daily dose (mg/kg/day).
Short-term PPE inhalation MOE = NOAEL (10 mg/kg/day) / daily dose (mg/kg/day). .

g Intermediate-term PPE dermal MOE = NOAEL (1.8 mg/kg/day based on an oral developmental study) / daily dose (mg/kg/day).
Intermediate-term PPE inhalation MOE = NOAEL (1.8 mg/kg/day) / daily dose (mg/kg/day). .
Aggregate MOE =NOAEL (1.8 mg/kg/day) / absorbed daily dermal + inhalation dose (mg/kg/day.

h Need information on number of pounds or volume of liquid fertilizer treated per day.

See PPE = no data at baseline, see exposures and risks with personal protective equipment

See Engineering Controls = no data at baseline or PPE, see exposures and risks with engineering controls

CRP = Conservation Reserve Program

UNK= Unknown

NA = not applicable

NG = no gloves; for flaggers gloves do not provide increased protection over baseline attire; PPE for flaggers is the addition of double-layer body protection to baseline attire.

NN= not needed -- MOEs greater than 100 at baseline

dl = double layer clothing

g = gloves

r = respirator

Bold = MOEs greater than 100 at this risk mitigation level do not exceed the Agency's level of concern

Table 7: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with Engineering Controls (Using PHED unit exposure values)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	Engineering Control Unit Exposure Values (PHED)		Short-term Risks with Engineering Controls (NN for dermal or inhalation for all scenarios)					Intermediate-term Risks with Engineering Controls				
				Dermal[c] (mg/lb ai)	Inhalation[d] (µg/lb ai)	Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)		MOEs[g]		
						Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Mixer/Loader															
Mixing/Loading Liquid Formulations for Aerial Application (1a)	conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL		350	0.0086	0.083	0.17	0.0019	2,100	5,200	1,500	0.012	0.0019	150	930	**130**
	sugarcane	2.6	350	0.0086	0.083	0.11	0.0013	3,200	7,900	2,300	0.0078	0.0013	230	1,400	**200**
	chemical fallow	3	1,200	0.0086	0.083	0.44	0.005	810	2,000	580	0.031	0.005	58	360	50
			350	0.0086	0.083	0.13	0.0015	2,800	6,900	2,000	0.009	0.0015	200	1,200	**170**
		1.4	1,200	0.0086	0.083	0.21	0.0023	1,700	4,300	1,200	0.014	0.0023	120	770	**110**
			350	0.0086	0.083	0.06	0.00068	6,000	15,000	4,300	0.0042	0.00068	430	2,700	370 (NN)
	CRP or grasslands	2	1,200	0.0086	0.083	0.29	0.0033	1,200	3,000	870	0.021	0.0033	87	540	75
			350	0.0086	0.083	0.086	0.00097	4,200	10,000	3,000	0.006	0.00097	300	1,900	260 (NN)
	corn, sorghum	2	1,200	0.0086	0.083	0.29	0.0033	1,200	3,000	870	0.021	0.0033	87	540	75
			350	0.0086	0.083	0.086	0.00097	4,200	10,000	3,000	0.006	0.00097	300	1,900	260 (NN)
		1	1,200	0.0086	0.083	0.15	0.0017	2,400	6,000	1,700	0.01	0.0017	170	1,100	**150**
			350	0.0086	0.083	0.043	0.00048	8,400	21,000	6,000	0.003	0.00048	600	3,700	520 (NN)
	sod farms	2	350	0.0086	0.083	0.086	0.00097	4,200	10,000	3,000	0.006	0.00097	300	1,900	260 (NN)

Table 7: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with Engineering Controls (Using PHED unit exposure values) (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	Engineering Control Unit Exposure Values (PHED)		Short-term Risks with Engineering Controls (NN for dermal or inhalation for all scenarios)					Intermediate-term Risks with Engineering Controls				
				Dermal[c] (mg/lb ai)	Inhalation[d] (µg/lb ai)	Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)		MOEs[g]		
						Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Mixing/Loading Liquid Formulations for Groundboom Application (1b)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	0.0086	0.083	0.039	0.00044	9,200	23,000	6,500	0.0028	0.00044	650	4,100	560 (NN)
	sugarcane	2.6	80	0.0086	0.083	0.026	0.00029	14,000	35,000	10,000	0.0018	0.00029	1,000	6,300	870 (NN)
	chemical fallow	3	450	0.0086	0.083	0.17	0.0019	2,200	5,400	1,500	0.012	0.0019	160	960	**130**
			200	0.0086	0.083	0.074	0.00083	4,900	12,000	3,500	0.0052	0.00083	350	2,200	300 (NN)
		1.4	450	0.0086	0.083	0.077	0.00087	4,700	11,000	3,300	0.0054	0.00087	330	2,100	290 (NN)
			200	0.0086	0.083	0.034	0.00039	10,000	26,000	7,500	0.0024	0.00039	750	4,600	640 (NN)
	CRP or grasslands	2	450	0.0086	0.083	0.11	0.0012	3,300	8,000	2,300	0.0077	0.0012	230	1,400	**200**
			200	0.0086	0.083	0.049	0.00055	7,300	18,000	5,200	0.0034	0.00055	520	3,300	450 (NN)
	corn, sorghum	2	450	0.0086	0.083	0.11	0.0012	3,300	8,000	2,300	0.0077	0.0012	230	1,400	**200**
			200	0.0086	0.083	0.049	0.00055	7,300	18,000	5,200	0.0034	0.00055	520	3,300	450 (NN)
		1	450	0.0086	0.083	0.055	0.00062	6,500	16,000	4,600	0.0039	0.00062	470	2,900	400 (NN)
			200	0.0086	0.083	0.025	0.00028	15,000	36,000	10,000	0.0017	0.00028	1,000	6,500	900 (NN)
	roadsides	1	40	0.0086	0.083	0.0049	0.000055	73,000	180,000	52,000	0.00034	0.000055	5,200	33,000	4,500 (NN)
	Bermuda grass hwy rights-of-way	4	40	0.0086	0.083	0.02	0.00022	18,000	45,000	13,000	0.0014	0.00022	1,300	8,100	1,100 (NN)
	golf course turf	2	40	0.0086	0.083	0.0098	0.00011	37,000	90,000	26,000	0.00069	0.00011	2,600	16,000	2,300 (NN)
	sod farms	2	80	0.0086	0.083	0.02	0.00022	18,000	45,000	13,000	0.0014	0.00022	1,300	8,100	1,100 (NN)
Mixing/Loading Liquid Formulations for Rights-of-Way Sprayer (1c)	roadsides	1	40	0.0086	0.083	0.0049	0.000055	73,000	180,000	52,000	0.00034	0.000055	5,200	33,000	4,500 (NN)
	Bermuda grass rights of way	4	40	0.0086	0.083	0.02	0.00022	18,000	45,000	13,000	0.0014	0.00022	1,300	8,100	1,100 (NN)
Mixing/Loading Liquid Formulations for Lawn Handgun Application (LCO) (1d)	lawns, golf courses	2	100	0.0086	0.083	0.025	0.00028	15,000	36,000	10,000	0.0017	0.00028	1,000	6,500	900 (NN)

Table 7: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with Engineering Controls (Using PHED unit exposure values) (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	Engineering Control Unit Exposure Values (PHED)		Short-term Risks with Engineering Controls (NN for dermal or inhalation for all scenarios)					Intermediate-term Risks with Engineering Controls				
				Dermal[c] (mg/lb ai)	Inhalation[d] (µg/lb ai)	Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)		MOEs[g]		
						Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Mixing/Loading/ Incorporating Liquid Formulations onto Dry Bulk Fertilizer (1e)	commercial fertilizer for corn, sorghum	2	NA	0.0086	0.083	2.4	0.027	150	380	110	0.17	0.027	11	68	9
						1.2	0.013	310	750	220	0.083	0.013	22	140	19
						0.67	0.0076	530	1,300	380	0.047	0.0076	38	240	33
		1				1.2	0.013	310	750	220	0.083	0.013	22	140	19
						0.59	0.0066	610	1,500	430	0.041	0.0066	44	270	38
						0.34	0.0038	1,100	2,600	760	0.024	0.0038	76	470	66
	on-farm fertilizer for corn, sorghum	2	500			0.12	0.0014	2,900	7,200	2,100	0.0086	0.0014	210	1,300	**180**
			250			0.061	0.00069	5,900	14,000	4,100	0.0043	0.00069	420	2,600	360 (NN)
			143			0.035	0.0004	10,000	25,000	7,300	0.0025	0.0004	730	4,500	630 (NN)
		1	500			0.061	0.00069	5,900	14,000	4,100	0.0043	0.00069	420	2,600	360 (NN)
			250			0.031	0.00035	12,000	29,000	8,300	0.0022	0.00035	840	5,200	720 (NN)
			143			0.018	0.0002	20,000	51,000	15,000	0.0012	0.0002	1,500	9,100	1,300 (NN)
Mixing/Loading Liquid Formulations into Liquid Bulk Fertilizer at Commercial Operations (1f)	fertilizer for corn, sorghum	2	UNK[h]	0.0086	0.083	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK
			UNK[h]			UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK
			UNK[h]			UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK
		1	UNK[h]			UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK
			UNK[h]			UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK
			UNK[h]			UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK	UNK

Table 7: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with Engineering Controls (Using PHED unit exposure values) (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	Engineering Control Unit Exposure Values (PHED)		Short-term Risks with Engineering Controls (NN for dermal or inhalation for all scenarios)					Intermediate-term Risks with Engineering Controls				
				Dermal[c] (mg/lb ai)	Inhalation[d] (µg/lb ai)	Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)		MOEs[g]		
						Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Mixing/Loading Dry Flowable (Water Dispersible Granule) for Aerial (2a)	conifer forests	4	1,200	0.0098	0.24	0.67	0.019	540	520	260	0.047	0.019	38	94	27
			350	0.0098	0.24	0.2	0.0056	1,800	1,800	910	0.014	0.0056	130	320	93
	sugarcane, conifer (Christmas tree) farms, turf for sod in FL	4	350	0.0098	0.24	0.2	0.0056	1,800	1,800	910	0.014	0.0056	130	320	93
	sugarcane	2.6	350	0.0098	0.24	0.13	0.0036	2,800	2,700	1,400	0.0089	0.0036	200	490	**140**
	chemical fallow	3	1,200	0.0098	0.24	0.5	0.014	710	690	350	0.035	0.014	51	130	36
			350	0.0098	0.24	0.15	0.0042	2,400	2,400	1,200	0.01	0.0042	170	430	**120**
		1.4	1,200	0.0098	0.24	0.24	0.0067	1,500	1,500	760	0.016	0.0067	110	270	78
			350	0.0098	0.24	0.069	0.002	5,200	5,100	2,600	0.0048	0.002	370	920	**270**
	CRP or grasslands	2	1,200	0.0098	0.24	0.34	0.0096	1,100	1,000	520	0.024	0.0096	77	190	54
			350	0.0098	0.24	0.098	0.0028	3,700	3,600	1,800	0.0069	0.0028	260	640	**190**
	corn, sorghum	2	1,200	0.0098	0.24	0.34	0.0096	1,100	1,000	520	0.024	0.0096	77	190	54
			350	0.0098	0.24	0.098	0.0028	3,700	3,600	1,800	0.0069	0.0028	260	640	**190**
		1	1,200	0.0098	0.24	0.17	0.0048	2,100	2,100	1,100	0.012	0.0048	150	380	**110**
			350	0.0098	0.24	0.049	0.0014	7,300	7,100	3,600	0.0034	0.0014	520	1,300	**370**
	sod farms	2	350	0.0098	0.24	0.098	0.0028	3,700	3,600	1,800	0.0069	0.0028	260	640	**190**

Table 7: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with Engineering Controls (Using PHED unit exposure values) (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	Engineering Control Unit Exposure Values (PHED)		Short-term Risks with Engineering Controls (NN for dermal or inhalation for all scenarios)					Intermediate-term Risks with Engineering Controls				
				Dermal[c] (mg/lb ai)	Inhalation[d] (µg/lb ai)	Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)		MOEs[g]		
						Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Mixing/Loading Dry Flowables (water dispersible) for Groundboom Application (2b)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	0.0098	0.24	0.045	0.0013	8,000	7,800	4,000	0.0031	0.0013	570	1,400	**410**
	sugarcane	2.6	80	0.0098	0.24	0.029	0.00083	12,000	12,000	6,100	0.002	0.00083	880	2,200	630 (NN)
	chemical fallow	3	450	0.0098	0.24	0.19	0.0054	1,900	1,900	950	0.013	0.0054	140	330	97
			200	0.0098	0.24	0.084	0.0024	4,300	4,200	2,100	0.0059	0.0024	310	750	**220**
		1.4	450	0.0098	0.24	0.088	0.0025	4,100	4,000	2000	0.0062	0.0025	290	710	**210**
			200	0.0098	0.24	0.039	0.0011	9,200	8,900	4500	0.0027	0.0011	660	1,600	470 (NN)
	CRP or grasslands	2	450	0.0098	0.24	0.13	0.0036	2,900	2,800	1400	0.0088	0.0036	200	500	**140**
			200	0.0098	0.24	0.056	0.0016	6,400	6,300	3200	0.0039	0.0016	460	1,100	**330**
	corn, sorghum	2	450	0.0098	0.24	0.13	0.0036	2,900	2,800	1400	0.0088	0.0036	200	500	**140**
			200	0.0098	0.24	0.056	0.0016	6,400	6,300	3200	0.0039	0.0016	460	1,100	**330**
		1	450	0.0098	0.24	0.063	0.0018	5,700	5,600	2800	0.0044	0.0018	410	1,000	**290**
			200	0.0098	0.24	0.028	0.0008	13,000	13,000	6500	0.002	0.0008	920	2,300	650 (NN)
	roadsides	1	40	0.0098	0.24	0.0056	0.00016	64,000	63,000	32,000	0.00039	0.00016	4,600	11,000	3,300 (NN)
		4	40	0.0098	0.24	0.022	0.00064	16,000	16,000	8000	0.0016	0.00064	1,100	2,800	820 (NN)
	golf course turf	2	40	0.0098	0.24	0.011	0.00032	32,000	31,000	16,000	0.00078	0.00032	2,300	5,600	1,600 (NN)
	sod farms	2	80	0.0098	0.24	0.022	0.00064	16,000	16,000	8000	0.0016	0.00064	1,100	2,800	820 (NN)
Mixing/Loading Dry Flowables (water dispersible) for Rights of Way (2c)	roadsides	1	40	0.0098	0.24	0.0056	0.00016	64,000	63,000	32,000	0.00039	0.00016	4,600	11,000	3,300 (NN)
	Bermuda grass hwy rights-of-way	4	40	0.0098	0.24	0.022	0.00064	16,000	16,000	8000	0.0016	0.00064	1,100	2,800	820 (NN)
Loading Granular Formulations (3)	sod farms	2	80	0.00017	0.034	0.00039	0.000091	930,000	110,000	98,000	0.000027	0.000091	66,000	20,000	15,000 (NN)
	golf course turf	2	40	0.00017	0.034	0.00019	0.000045	1,900,000	220,000	200,000	0.000014	0.000045	130,000	40,000	31,000 (NN)

Table 7: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with Engineering Controls (Using PHED unit exposure values) (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	Engineering Control Unit Exposure Values (PHED)		Short-term Risks with Engineering Controls (NN for dermal or inhalation for all scenarios)					Intermediate-term Risks with Engineering Controls				
				Dermal[c] (mg/lb ai)	Inhalation[d] (µg/lb ai)	Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)		MOEs[g]		
						Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Applicator															
Applying Liquids with Aircraft (4)	conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL	4	350	0.0050	0.068	0.1	0.0016	3,600	6,300	2,300	0.007	0.0016	260	1,100	**210**
	sugarcane	2.6	350	0.0050	0.068	0.065	0.001	5,500	9,700	3,500	0.0046	0.001	400	1,700	**320**
	chemical fallow	3	1,200	0.0050	0.068	0.26	0.0041	1,400	2,500	900	0.018	0.0041	100	440	82
			350	0.0050	0.068	0.075	0.0012	4,800	8,400	3,100	0.0053	0.0012	340	1,500	**280**
		1.4	1,200	0.0050	0.068	0.12	0.0019	3,000	5,300	1,900	0.0084	0.0019	210	950	**170**
			350	0.0050	0.068	0.035	0.00056	10,000	18,000	6,500	0.0025	0.00056	730	3,200	**600**
	CRP or grasslands	2	1,200	0.0050	0.068	0.17	0.0027	2,100	3,700	1,300	0.012	0.0027	150	660	**120**
			350	0.0050	0.068	0.05	0.00079	7,200	13,000	4,600	0.0035	0.00079	510	2,300	**420**
	corn, sorghum	2	1,200	0.0050	0.068	0.17	0.0027	2,100	3,700	1,300	0.012	0.0027	150	660	**120**
			350	0.0050	0.068	0.05	0.00079	7,200	13,000	4,600	0.0035	0.00079	510	2,300	**420**
		1	1,200	0.0050	0.068	0.086	0.0014	4,200	7,400	2,700	0.006	0.0014	300	1,300	**240**
			350	0.0050	0.068	0.025	0.0004	14,000	25,000	9,100	0.0018	0.0004	1,000	4,500	**840**
	sod farms	2	350	0.0050	0.068	0.05	0.00079	7,200	13,000	4,600	0.0035	0.00079	510	2,300	**420**

Table 7: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with Engineering Controls (Using PHED unit exposure values) (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	Engineering Control Unit Exposure Values (PHED)		Short-term Risks with Engineering Controls (NN for dermal or inhalation for all scenarios)					Intermediate-term Risks with Engineering Controls				
				Dermal[c] (mg/lb ai)	Inhalation[d] (µg/lb ai)	Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)		MOEs[g]		
						Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Applying Liquids for Groundboom Application (5)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	0.005	0.043	0.023	0.00023	16,000	44,000	12,000	0.0016	0.00023	1,100	7,800	980 (NN)
	sugarcane	2.6	80	0.005	0.043	0.015	0.00015	24,000	67,000	18,000	0.001	0.00015	1,700	12,000	1,500 (NN)
	chemical fallow	3	450	0.005	0.043	0.096	0.00097	3,700	10,000	2,700	0.0068	0.00097	270	1,900	**230**
			200	0.005	0.043	0.043	0.00043	8,400	23,000	6,200	0.003	0.00043	600	4,200	520 (NN)
		1.4	450	0.005	0.043	0.045	0.00045	8,000	22,000	5,900	0.0032	0.00045	570	4,000	500 (NN)
			200	0.005	0.043	0.02	0.0002	18,000	50,000	13,000	0.0014	0.0002	1,300	9,000	1,100 (NN)
	CRP or grasslands	2	450	0.005	0.043	0.064	0.00065	5,600	16,000	4,100	0.0045	0.00065	400	2,800	350 (NN)
			200	0.005	0.043	0.029	0.00029	13,000	35,000	9,300	0.002	0.00029	900	6,300	790 (NN)
	corn, sorghum	2	450	0.005	0.043	0.064	0.00065	5,600	16,000	4,100	0.0045	0.00065	400	2,800	350 (NN)
			200	0.005	0.043	0.029	0.00029	13,000	35,000	9,300	0.002	0.00029	900	6,300	790 (NN)
		1	450	0.005	0.043	0.032	0.00032	11,000	31,000	8,200	0.0023	0.00032	800	5,600	700 (NN)
			200	0.005	0.043	0.014	0.00014	25,000	70,000	19,000	0.001	0.00014	1,800	13,000	1,600 (NN)
	Bermuda grass rights-of-way	4	40	0.005	0.043	0.011	0.00011	32,000	87,000	23,000	0.0008	0.00011	2,300	16,000	2,000 (NN)
	roadsides	1	40	0.005	0.043	0.0029	0.000029	130,000	350,000	93,000	0.0002	0.000029	9,000	63,000	7,900 (NN)
	golf course turf	2	40	0.005	0.043	0.0057	0.000057	63,000	170,000	46,000	0.0004	0.000057	4,500	31,000	3,900 (NN)
	sod farms	2	80	0.005	0.043	0.011	0.00011	32,000	87,000	23,000	0.0008	0.00011	2,300	16,000	2,000 (NN)
Applying Liquids with a Rights-of-Way Sprayer (6)	Bermuda grass hwy rights of way	4	40	NF	NF	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF	NF	NF	NF	NF
	roadsides	1	40	NN	NN	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)
Applying Liquids with a Handgun (7)	lawns, golf courses	2	5	NN	NN	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)

Table 7: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with Engineering Controls (Using PHED unit exposure values) (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	Engineering Control Unit Exposure Values (PHED)		Short-term Risks with Engineering Controls (NN for dermal or inhalation for all scenarios)					Intermediate-term Risks with Engineering Controls				
				Dermal[c] (mg/lb ai)	Inhalation[d] (µg/lb ai)	Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)		MOEs[g]		
						Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
Applying Impregnated Dry Bulk Granular Fertilizer with Tractor Drawn Spreader(8)	corn, sorghum	2	500	0.002	0.22	0.029	0.0037	13,000	2,700	2,200	0.002	0.0037	900	490	320 (NN)
			250	0.002	0.22	0.014	0.0018	25,000	5,500	4,500	0.001	0.0018	1,800	980	640 (NN)
			143	0.002	0.22	0.0082	0.001	44,000	9,500	7,800	0.00057	0.001	3,100	1,700	1,100 (NN)
		1	500	0.002	0.22	0.014	0.0018	25,000	5,500	4,500	0.001	0.0018	1,800	980	640 (NN)
			250	0.002	0.22	0.0071	0.00092	50,000	11,000	9,000	0.0005	0.00092	3,600	2,000	1,300 (NN)
			143	0.002	0.22	0.0041	0.00052	88,000	19,000	16,000	0.00029	0.00052	6,300	3,400	2,200 (NN)
Applying Granular with a Tractor Drawn Spreader (9)	on farm fertilizer for corn, sorghum?	2	200	0.002	0.22	0.011	0.0015	32,000	6,800	5,600	0.0008	0.0015	2,300	1,200	790 (NN)
			80	0.002	0.22	0.0046	0.00059	79,000	17,000	14,000	0.00032	0.00059	5,600	3,100	2,000 (NN)
		1	200	0.002	0.22	0.0057	0.00073	63,000	14,000	11,000	0.0004	0.00073	4,500	2,500	1,600 (NN)
			80	0.002	0.22	0.0023	0.00029	160,000	34,000	28,000	0.00016	0.00029	11,000	6,100	4,000 (NN)
	golf course turf	2	40	0.002	0.22	0.0023	0.00029	160,000	34,000	28,000	0.00016	0.00029	11,000	6,100	4,000 (NN)
Mixer/Loader/Applicator															
Backpack Sprayer (LCO): Liquid Formulations (10)	lawns, golf courses	2	5	NF	NF	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)
Low Pressure Handwand - Liquid Formulations (LCO) (11)	lawns, golf courses	2	5	NN	NN	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)
Lawn Handgun (and Compressed Air Sprayer) (LCO) (12)	lawns, golf courses	2	5	0.2 (eng = M/L only)	0.36 (eng = M/L only)	0.029 (eng = M/L only)	0.00006 (eng = M/L only)	13,000 (eng = M/L only)	170,000 (eng = M/L only)	12,000 (eng = M/L only)	0.002 (eng = M/L only)	0.00006 (eng = M/L only)	900 (eng = M/L only)	30,000 (eng = M/L only)	870 (NN) (eng = M/L only)
Granulars with a Push Type Spreader (LCO) (13)	lawns, golf courses	2	5	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)
Granulars with a Bellygrinder (LCO) (14)	lawns, golf courses	2	1	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)	NF (NN)

Table 7: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with Engineering Controls (Using PHED unit exposure values) (continued)

Exposure Scenario	Crop Type	Application Rate[a]	Acres Treated[b]	Engineering Control Unit Exposure Values (PHED)		Short-term Risks with Engineering Controls (NN for dermal or inhalation for all scenarios)					Intermediate-term Risks with Engineering Controls				
				Dermal[c] (mg/lb ai)	Inhalation[d] (µg/lb ai)	Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)		MOEs[g]		
						Dermal	Inhalation	Dermal	Inhalation	Aggregate	Dermal	Inhalation	Dermal	Inhalation	Aggregate
				Flagging											
Flagging Sprays (15)	conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms	4	350	0.005	0.043	0.1	0.001	3,600	10,000	2,600	0.007	0.001	260	1,800	**220**
	sugarcane	2.6	350	0.005	0.043	0.065	0.00065	5,500	15,000	4,000	0.0046	0.001	400	2,800	350 (NN)
	chemical fallow	3	1,200	0.005	0.043	0.26	0.0026	1,400	3,900	1,000	0.018	0.0026	100	700	87
			350	0.005	0.043	0.075	0.00075	4,800	13,000	3,500	0.0053	0.00075	340	2,400	300 (NN)
		1.4	1,200	0.005	0.043	0.12	0.0012	3,000	8,300	2,200	0.0084	0.0012	210	1,500	**190**
			350	0.005	0.043	0.035	0.00035	10,000	28,000	7,500	0.0025	0.00035	730	5,100	640 (NN)
	CRP or grasslands	2	1,200	0.005	0.043	0.17	0.0017	2,100	5,800	1,500	0.012	0.0017	150	1,000	**130**
			350	0.005	0.043	0.05	0.0005	7,200	20,000	5,300	0.0035	0.0005	510	3,600	450 (NN)
	corn, sorghum	2	1,200	0.005	0.043	0.17	0.0017	2,100	5,800	1,500	0.012	0.0017	150	1,000	**130**
			350	0.005	0.043	0.05	0.0005	7,200	20,000	5,300	0.0035	0.0005	510	3,600	450 (NN)
		1	1,200	0.005	0.043	0.086	0.00086	4,200	12,000	3,100	0.006	0.00086	300	2,100	**260**
			350	0.005	0.043	0.025	0.00025	14,000	40,000	11,000	0.0018	0.00025	1,000	7,200	900 (NN)
	sod farms	2	350	0.005	0.043	0.05	0.0005	7,200	20,000	5,300	0.0035	0.0005	510	3,600	450 (NN)

Footnotes:

a Application rates represent maximum rates determined from EPA registered labels for atrazine. Typical use rates as determined by BEAD were assessed for corn and sorghum (1.0 lb ai/acre), sugarcane (2.6 lb ai/acre) and chemical fallow (1.4 lb ai/acre).

b Acres treated per day based on Exposure SAC Policy # 9 "Standard Values for Daily Acres Treated In Agriculture," Revised June 23, 2000.

c Engineering control dermal unit exposure values from PHED Surrogate Exposure Guide - Draft August, 1998 represent:

1a, 1b, 1c, 1d, 1e, 1f:	closed mixing, single layer clothing, and chemical resistant gloves
2a, 2b, 2c	water soluble packets, single layer clothing, and chemical resistant gloves
3	lock and load , single layer clothing and chemical resistant gloves
4,	enclosed cockpit/cockpit, single layer clothing and no gloves
5, 8, 9	enclosed cab, single layer clothing and no gloves
12	chemical resistant gloves plus water-soluble packaging for mixing/loading, and plus double-layer body protection for application and
15	enclosed cab, single layer of clothing and no gloves

d Engineering control inhalation unit exposure values from PHED Surrogate Exposure Guide - Draft August 1998 represent used of a dust/mist respirator (80 percent protection factor over baseline).

e Dermal daily dose (mg/kg/day) = daily unit exposure (mg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) / body weight (70 kg adult for short-term and 60 kg adult female -- for developmental effects -- for intermediate-term assessment). For intermediate-term dermal dose an absorption factor of 6 percent applies.
Inhalation daily dose (mg/kg/day) = inhalation unit exposure (µg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) x conversion factor (1 mg/1,000 µg) / body weight (60 kg developmental female for both short-term and intermediate-term assessment).

Table 7: Occupational Short-term and Intermediate-term Handler Risks from Atrazine with Engineering Controls (Using PHED unit exposure values) (continued)

f Short-term dermal MOE = NOAEL (360 mg/kg/day based on a dermal rat study) / daily dose (mg/kg/day).
Short-term inhalation MOE = NOAEL (10 mg/kg/day) / daily dose (mg/kg/day). .
g Intermediate-term dermal MOE = NOAEL (1.8 mg/kg/day based on an oral developmental study) / daily dose (mg/kg/day).
h Need information on number of pounds or volume of liquid fertilizer treated per day.
CRP = Conservation Reserve Program
UNK = Unknown -- additional use information needed
NN = Not needed -- MOE > 100 at previous risk mitigation level
NF = Not feasible -- no engineering control known for this application method
Bold = uncertainty factor (MOE) reached or exceeded at that risk mitigation level
Shaded = uncertainty factor (MOE) not attained at maximum feasible risk mitigation

Table 8: Occupational Short-and Intermediate-Term Handler Risks from Atrazine with Engineering Controls (Using Unit Exposure Values Submitted by Novartis Crop Protection, Inc. MRID 443154-04)

Exposure Scenario	Crop Type	Application Rate[a] (lb ai/acre)	Amount Handled per day[b] (acres)	Eng Con Unit Exposure [c] MRID 443154-04 (Novartis)[d]		Short-Term Risks with Engineering Controls					Intermediate-Term Risks with Engineering Controls				
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)		MOEs[g]		
				Dermal (mg/ lb ai)	Inhalation (µg/lb ai)	Dermal	Inhalation	Dermal	Inhalation	Aggre-gate	Dermal	Inhalation	Dermal	Inhalation	Aggre-gate
Mixer/Loader															
Mixing/Loading Liquid Formulations for Aerial Application (1a)	conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL	4	350	0.01	0.13	0.2	0.003	1,800	3,300	1200	0.014	0.003	130	590	**110**
	sugarcane	2.6	350			0.13	0.002	2,800	5,100	1800	0.0091	0.002	200	910	**160**
	chemical fallow	3	1,200			0.51	0.0078	700	1,300	460	0.036	0.0078	50	230	41
			350			0.15	0.0023	2,400	4,400	1600	0.011	0.0023	170	790	**140**
		1.4	1,200			0.24	0.0036	1,500	2,700	960	0.017	0.0036	110	490	88
			350			0.07	0.0011	5,100	9,400	3300	0.0049	0.0011	370	1,700	**300**
	CRP or grasslands	2	1,200			0.34	0.0052	1,100	1,900	680	0.024	0.0052	75	350	62
			350			0.1	0.0015	3,600	6,600	2300	0.007	0.0015	260	1,200	**210**
	corn, sorghum	2	1,200			0.34	0.0052	1,100	1,900	680	0.024	0.0052	75	350	62
			350			0.1	0.0015	3,600	6,600	2300	0.007	0.0015	260	1,200	**210**
		1	1,200			0.17	0.0026	2,100	3,800	1400	0.012	0.0026	150	690	**120**
			350			0.05	0.00076	7,200	13,000	4600	0.0035	0.00076	510	2,400	**420**
	sod farms	2	350			0.1	0.0015	3,600	6,600	2300	0.007	0.0015	260	1,200	**210**

Table 8: Occupational Short-and Intermediate-Term Handler Risks from Atrazine with Engineering Controls (Using Unit Exposure Values Submitted by Novartis Crop Protection, Inc. MRID 443154-04) (continued)

Exposure Scenario	Crop Type	Application Rate[a] (lb ai/acre)	Amount Handled per day[b] (acres)	Eng Con Unit Exposure [c] MRID 443154-04 (Novartis)[d]		Short-Term Risks with Engineering Controls					Intermediate-Term Risks with Engineering Controls				
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)		MOEs[g]		
				Dermal (mg/ lb ai)	Inhalation (µg/lb ai)	Dermal	Inhalation	Dermal	Inhalation	Aggre-gate	Dermal	Inhalation	Dermal	Inhalation	Aggre-gate
Mixing/Loading Liquid Formulations for Groundboom Application (1b)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	0.01	0.13	0.046	0.00069	7,900	14,000	5,000	0.0032	0.00069	560	2,600	**460**
	sugarcane	2.6	80			0.03	0.00045	12,000	22,000	7,800	0.0021	0.00045	870	4,000	**710**
	chemical fallow	3	450			0.19	0.0029	1,900	3,400	1,200	0.014	0.0029	130	620	**110**
			200			0.086	0.0013	4,200	7,700	2,700	0.006	0.0013	300	1,400	**250**
		1.4	450			0.09	0.0014	4,000	7,300	2,600	0.0063	0.0014	290	1,300	**230**
			200			0.04	0.00061	9,000	16,000	5,800	0.0028	0.00061	640	3,000	**530**
	CRP or grasslands	2	450			0.13	0.002	2,800	5,100	1,800	0.009	0.002	200	920	**160**
			200			0.057	0.00087	6,300	12,000	4,100	0.004	0.00087	450	2,100	**370**
	corn, sorghum	2	450			0.13	0.002	2,800	5,100	1,800	0.009	0.002	200	920	**160**
			200			0.057	0.00087	6,300	12,000	4,100	0.004	0.00087	450	2,100	**370**
		1	450			0.064	0.00098	5,600	10,000	3,600	0.0045	0.00098	400	1,800	**330**
			200			0.029	0.00043	13,000	23,000	8,100	0.002	0.00043	900	4,200	**740**
	roadsides	1	40			0.0057	0.000087	63,000	120,000	41,000	0.0004	0.000087	4,500	21,000	**3,700**
	Bermuda grass hwy rights-of- way	4	40			0.023	0.00035	16,000	29,000	10,000	0.0016	0.00035	1,100	5,200	**920**
	golf course turf	2	40			0.011	0.00017	32,000	58,000	20,000	0.0008	0.00017	2,300	10,000	**1,800**
	sod farms	2	80			0.023	0.00035	16,000	29,000	10,000	0.0016	0.00035	1,100	5,200	**920**
Mixing/Loading Liquid Formulations for Rights-of-Way Sprayer (1c)	Bermuda grass hwy rights-of- way	4	40			0.023	0.00035	16,000	29,000	41,000	0.0016	0.00035	1,100	5,200	**920**
	roadsides	1	40			0.0057	0.000087	63,000	120,000	10,000	0.0004	0.000087	4,500	21,000	**3,700**
Mixing/Loading Liquid Formulations for Lawn Handgun Application (LCO) (1d)	lawns, golf courses	2	100			0.029	0.00043	13,000	23,000	8,100	0.002	0.00043	900	4,200	**740**

Table 8: Occupational Short-and Intermediate-Term Handler Risks from Atrazine with Engineering Controls (Using Unit Exposure Values Submitted by Novartis Crop Protection, Inc. MRID 443154-04) (continued)

Exposure Scenario	Crop Type	Application Rate[a] (lb ai/acre)	Amount Handled per day[b] (acres)	Eng Con Unit Exposure [c] MRID 443154-04 (Novartis)[d]		Short-Term Risks with Engineering Controls					Intermediate-Term Risks with Engineering Controls				
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)		MOEs[g]		
				Dermal (mg/ lb ai)	Inhalation (µg/lb ai)	Dermal	Inhalation	Dermal	Inhalation	Aggre-gate	Dermal	Inhalation	Dermal	Inhalation	Aggre-gate
Mixing/Loading/Incorporating Liquid Formulations onto Dry Bulk Fertilizer (1e)	commercial fertilizer for corn, sorghum	2	NA[h]	0.01	0.13	2.7	0.042	130	240	85	0.19	0.042	9	43	8
						1.4	0.021	260	480	170	0.096	0.021	19	87	15
						0.78	0.012	460	840	300	0.055	0.012	33	150	27
		1				1.4	0.021	260	480	170	0.096	0.021	19	87	15
						0.69	0.01	530	960	340	0.048	0.01	38	170	31
						0.39	0.0059	920	1,700	600	0.027	0.0059	66	300	54
	on-farm fertilizer for corn, sorghum	2	500			0.14	0.0022	2,500	4,600	1,600	0.01	0.0022	180	830	**150**
			250			0.071	0.0011	5,000	9,200	3,300	0.005	0.0011	360	1,700	**300**
			143			0.041	0.00062	8,800	16,000	5,700	0.0029	0.00062	630	2,900	**520**
		1	500			0.071	0.0011	5,000	9,200	3,300	0.005	0.0011	360	1,700	**300**
			250			0.036	0.00054	10,000	18,000	6,500	0.0025	0.00054	720	3,300	**590**
			143			0.02	0.00031	18,000	32,000	11,000	0.0014	0.00031	1,300	5,800	**1,000**
Mixing/Loading Liquid Formulations into Liquid Bulk Fertilizer at Commercial Operations (1f)	fertilizer for corn, sorghum	2	UNK			No Data									
			UNK			No Data									
			UNK			No Data									
		1	UNK			No Data									
			UNK			No Data									
			UNK			No Data									

Table 8: Occupational Short-and Intermediate-Term Handler Risks from Atrazine with Engineering Controls (Using Unit Exposure Values Submitted by Novartis Crop Protection, Inc. MRID 443154-04) (continued)

Exposure Scenario	Crop Type	Application Rate[a] (lb ai/acre)	Amount Handled per day[b] (acres)	Eng Con Unit Exposure [c] MRID 443154-04 (Novartis)[d]		Short-Term Risks with Engineering Controls					Intermediate-Term Risks with Engineering Controls				
						Daily Dose[e] (mg/kg/day)		MOEs[f]			Daily Dose[e] (mg/kg/day)		MOEs[g]		
				Dermal (mg/ lb ai)	Inhalation (µg/lb ai)	Dermal	Inhalation	Dermal	Inhalation	Aggre-gate	Dermal	Inhalation	Dermal	Inhalation	Aggre-gate
Applicator															
Applying Liquids for Groundboom Application (5)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	0.0083	0.047	0.038	0.00025	9,500	170,000	9,000	0.0027	0.00025	680	7,200	**620**
	sugarcane	2.6	80			0.025	0.00016	15,000	260,000	14,000	0.0017	0.00016	1,000	11,000	**950**
	chemical fallow	3	450			0.16	0.0011	2,200	40,000	2,100	0.011	0.0011	160	1,700	**150**
			200			0.071	0.00047	5,100	91,000	4,800	0.005	0.00047	360	3,800	**330**
		1.4	450			0.075	0.00049	4,800	87,000	4,600	0.0052	0.00049	340	3,600	**310**
			200			0.033	0.00022	11,000	190,000	10,000	0.0023	0.00022	770	8,200	**710**
	CRP or grasslands	2	450			0.11	0.00071	3,400	61,000	3,200	0.0075	0.00071	240	2,600	**220**
			200			0.047	0.00031	7,600	140,000	7,200	0.0033	0.00031	540	5,700	**500**
	corn, sorghum	2	450			0.11	0.00071	3,400	61,000	3,200	0.0075	0.00071	240	2,600	**220**
			200			0.047	0.00031	7,600	140,000	7,200	0.0033	0.00031	540	5,700	**500**
		1	450			0.053	0.00035	6,700	120,000	6,400	0.0037	0.00035	480	5,100	**440**
			200			0.024	0.00016	15,000	270,000	14,000	0.0017	0.00016	1,100	11,000	**990**
	Bermuda grass hwy rights-of- way	4	40			0.019	0.00013	19,000	80,000	15,000	0.0013	0.00013	1,400	14,000	**1,200**
	roadsides	1	40			0.0047	0.000031	76,000	320,000	61,000	0.00033	0.000031	5,400	57,000	**5,000**
	golf course turf	2	40			0.0095	0.000063	38,000	160,000	31,000	0.00066	0.000063	2,700	29,000	**2,500**
	sod farms	2	80			0.019	0.00013	19,000	80,000	15,000	0.0013	0.00013	1,400	14,000	**1,200**

Footnotes:

a Application rates represent maximum rates determined from EPA registered labels for atrazine. Typical use rates as determined by BEAD were assessed for corn and sorghum (1.0 lb ai/acre), sugarcane (2.6 lb ai/acre) and chemical fallow (1.4 lb ai/acre).

b Acres treated per day based on Exposure SAC Policy # 9 "Standard Values for Daily Acres Treated In Agriculture," Revised June 23, 2000.

c Engineering control dermal unit exposure values taken from study data submitted by Novartis Crop Protection Inc.
1a, 1b, 1c, 1d, 1e, 1f: closed mixing, single layer clothing, and chemical resistant gloves
5 enclosed cab, single layer clothing and no gloves

d Engineering control inhalation unit exposure values from PHED Surrogate Exposure Guide - Draft August 1998 represent used of a dust/mist respirator (80 percent protection factor over baseline).

Table 8: Occupational Short-and Intermediate-Term Handler Risks from Atrazine with Engineering Controls (Using Unit Exposure Values Submitted by Novartis Crop Protection, Inc. MRID 443154-04) (continued)

e Dermal daily dose (mg/kg/day) = daily unit exposure (mg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) / body weight (70 kg adult for short-term and 60 kg adult female -- for developmental effects -- for intermediate-term assessment). For intermediate-term dermal dose an absorption factor of 6 percent applies.
Inhalation daily dose (mg/kg/day) = inhalation unit exposure (µg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) x conversion factor (1 mg/1,000 µg) / body weight (60 kg developmental female for both short-term and intermediate-term assessment).

f Short-term dermal MOE = NOAEL (360 mg/kg/day based on a dermal rat study) / daily dose (mg/kg/day).
Short-term inhalation MOE = NOAEL (10 mg/kg/day) / daily dose (mg/kg/day). .

g Intermediate-term dermal and inhalation MOE = NOAEL (1.8 mg/kg/day based on an oral developmental study) / daily dose (mg/kg/day).

h Need information on number of pounds or volume of liquid fertilizer treated per day.

CRP = Conservation Reserve Program

UNK = Unknown -- additional use information needed

NN = Not needed -- MOE > 100 at previous risk mitigation level

NF = Not feasible -- no engineering control known for this application method

Bold = uncertainty factor (MOE) reached or exceeded at that risk mitigation level

Shaded = uncertainty factor (MOE) not attained at maximum feasible risk mitigation

Table 9: Summary of Occupational Short-term and Intermediate-term Handler Risks from Atrazine (Using PHED Data)

Handler Scenario				Baseline MOEs[c]		PPE MOEs[c]		Engineering Control MOEs[e]	
				Short-term	Intermediate-term	Short-term	Intermediate-term	Short-term	Intermediate-term
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre or lb ai/gal)	Area Treated Per Day[b] (Acres)	Aggregate Dermal + Inhalation	Aggregate Dermal + Inhalation	Aggregate: with gloves unless noted and with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted	Aggregate Dermal + Inhalation (NN at all scenarios)	Aggregate Dermal + Inhalation
Mixer/Loader									
Mixing/Loading Liquid Formulations for Aerial Application (1a)	Conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL	4	350	6	0.44	**540**	61	1,500	**130**
	sugarcane	2.6	350	9	0.68	**840**	94	2,300	**200**
	chemical fallow	3	1,200	2	0.17	**210**	24	580	50
			350	8	0.59	**730**	82	2,000	**170**
		1.4	1,200	5	0.37	**450**	51 g,dl	1,200	**110**
			350	17	1.3	**1600**	**99 g,dl**	4,300	370 (NN)
	CRP or grasslands	2	1,200	4	0.26	**320**	36	870	75
			350	12	0.88	**1100**	**120**	3,000	260 (NN)
	corn, sorghum	2	1,200	4	0.26	**320**	36	870	**75**
			350	12	0.88	**1100**	**120**	3,000	260 (NN)
		1	1,200	7	0.51	**630**	71	1,700	**150**
			350	24	1.8	**2200**	**120 g**	6,000	520 (NN)
	sod farms	2	350	12	0.88	**1100**	**120**	3,000	260 (NN)
Mixing/Loading Liquid Formulations for Groundboom Application (1b)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	27	1.9	**2400**	**130 g**	6,500	560 (NN)
	sugarcane	2.6	80	41	3.0	**3700**	**200 g**	10,000	870 (NN)
	chemical fallow	3	450	6	0.46	**560**	63	1,500	**130**
			200	14	1.0	**1300**	**110 g,r**	3,500	300 (NN)
		1.4	450	14	0.98	**1200**	**110 g,r**	3,300	290 (NN)
			200	31	2.2	**2700**	**150 g**	7,500	640 (NN)
	CRP/grasslands	2	450	9	0.68	**850**	95	2,300	**200**
			200	21	1.5	**1900**	**100 g**	5,200	450 (NN)
	corn, sorghum	2	450	9	0.68	**850**	95	2,300	**200**
			200	21	1.5	**1900**	**100 g**	5,200	450 (NN)
		1	450	19	1.4	**1700**	**110 g,dl**	4,600	400 (NN)
			200	43	3.1	**3800**	**210 g**	10,000	900 (NN)
	roadsides	1	40	210	15	19000	**1,000 g**	52,000	4,500 (NN)
	Bermuda grass rights-of-way	4	40	53	3.9	**4800**	**260 g**	13,000	1,100 (NN)
	golf course turf	2	40	110	7.7	9500	**520 g**	26,000	2,300 (NN)

Table 9: Summary of Occupational Short-term and Intermediate-term Handler Risks from Atrazine (continued)

Handler Scenario				Baseline MOEs[c]		PPE MOEs[c]		Engineering Control MOEs[e]	
				Short-term	Intermediate-term	Short-term	Intermediate-term	Short-term	Intermediate-term
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre or lb ai/gal)	Area Treated Per Day[b] (Acres)	Aggregate Dermal + Inhalation	Aggregate Dermal + Inhalation	Aggregate: with gloves unless noted and with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted	Aggregate Dermal + Inhalation (NN at all scenarios)	Aggregate Dermal + Inhalation
	sod farms	2	80	53	3.9	**4800**	**260 g**	13,000	1,100 (NN)
Mixing/Loading Liquid Formulations for Rights-of-Way Sprayer (1c)	roadsides	1	40	210	15	19000	**1,000 g**	52,000	4,500 (NN)
	Bermuda grass hwy rights-of-way	4	40	53	3.9	**4800**	**260 g**	13,000	1,100 (NN)
Mixing/Loading Liquid Formulations for Lawn Handgun Application (LCO) (1d)	lawns, golf courses	2	100	43	3.1	**3800**	**210 g**	10,000	900 (NN)
Mixing/Loading/ Incorporating Liquid Formulations onto Dry Bulk Fertilizer (1e)	commercial fertilizer for corn, sorghum	2	NA 700 lb fert/day	See Engineering Controls				110	9
			NA 400 lb fert/day	See Engineering Controls				220	19
			NA 200 lb fert/day	See Engineering Controls				380	33
	commercial fertilizer for corn, sorghum	1	NA 700 lb fert/day	See Engineering Controls				220	19
			NA 400 lb fert/day	See Engineering Controls				430	38
			NA 200 lb fert/day	See Engineering Controls				760	66
	on-farm fertilizer for corn, sorghum	2	500	8.5	0.62	**760**	86	2,100	**180**
			250	17	1.2	**1500**	**97 g,dl**	4,100	360 (NN)
			143	30	2.2	**2700**	**150 g**	7,300	630 (NN)
		1	500	17	1.2	**1500**	**97 g,dl**	4,100	360 (NN)
			250	34	2.4	**3000**	**170 g**	8,300	720 (NN)
			143	60	4.3	**5300**	**290 g**	15,000	1,300 (NN)

Table 9: Summary of Occupational Short-term and Intermediate-term Handler Risks from Atrazine (continued)

Handler Scenario				Baseline MOEs[c]		PPE MOEs[c]		Engineering Control MOEs[e]	
				Short-term	Intermediate-term	Short-term	Intermediate-term	Short-term	Intermediate-term
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre or lb ai/gal)	Area Treated Per Day[b] (Acres)	Aggregate Dermal + Inhalation	Aggregate Dermal + Inhalation	Aggregate: with gloves unless noted and with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted	Aggregate Dermal + Inhalation (NN at all scenarios)	Aggregate Dermal + Inhalation
Mixing/Loading Liquid Formulations into Liquid Bulk Fertilizer at Commercial Operations (1f)	fertilizer for corn, sorghum	2	UNK	No Data					
			UNK	No Data					
			UNK	No Data					
		1	UNK	No Data					
			UNK	No Data					
			UNK	No Data					
Mixing/Loading Dry Flowable (Water Dispersible Granule) for Aerial (2a)	conifer forests, sugarcane, conifer (Christmas tree) farms, turf for sod in FL	4	350	180	16	250	26	910	93
	sugarcane	2.6	350	280	25	380	40	1,400	**140**
	chemical fallow	3	1,200	71	6.3	97	10	350	36
			350	240	22	330	35	1,200	**120**
		1.4	1,200	150	14	210	22	760	78
			350	520	47	710	61 g,dl	2,600	**270**
	CRP or grasslands	2	1,200	110	9.5	140	15	520	54
			350	370	33	500	43 g,dl	1,800	**190**
	corn, sorghum	2	1,200	110	9.5	140	15	520	54
			350	370	33	500	43 g,dl	1,800	**190**
		1	1,200	210	19	290	30	1,100	**110**
			350	730	65	990	86 g,dl	3,600	**370**
	sod farms	2	350	370	33	500	43 g,dl	1,800	**190**

Table 9: Summary of Occupational Short-term and Intermediate-term Handler Risks from Atrazine (continued)

Handler Scenario				Baseline MOEs[c]		PPE MOEs[c]		Engineering Control MOEs[e]	
				Short-term	Intermediate-term	Short-term	Intermediate-term	Short-term	Intermediate-term
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre or lb ai/gal)	Area Treated Per Day[b] (Acres)	Aggregate Dermal + Inhalation	Aggregate Dermal + Inhalation	Aggregate: with gloves unless noted and with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted	Aggregate Dermal + Inhalation (NN at all scenarios)	Aggregate Dermal + Inhalation
Mixing/Loading Dry Flowables (water dispersible) for Groundboom Application (2b)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	800	71	1100 (NN)	94 g,dl	4,000	**410**
	sugarcane	2.6	80	1200	**110**	1700	110 g (NN)	6,100	630 (NN)
	chemical fallow	3	450	190	17	260	27	950	97
			200	430	38	580	50 g,dl	2,100	**220**
		1.4	450	410	36	550	48 g,dl	2000	**210**
			200	920	82	1200	**110 g,dl**	4500	470 (NN)
	CRP or grasslands	2	450	280	25	390	40	1400	**140**
			200	640	57	870	75 g,dl	3200	**330**
	corn, sorghum	2	450	280	25	390	40	1400	**140**
			200	640	57	870	75 g,dl	3200	**330**
		1	450	570	51	770	67 g,dl	2800	**290**
			200	1300	**110**	1700	150 g,dl (NN)	6500	650 (NN)
	roadsides	1	40	6400	**570**	8700	570 g (NN)	32,000	3,300 (NN)
	Bermuda grass rights-of- way	4	40	1600	**140**	2200	140 g (NN)	8000	820 (NN)
	golf course turf	2	40	3200	**290**	4300	290 g (NN)	16,000	1,600 (NN)
	sod farms	2	80	1600	**140**	2200	140 g (NN)	8000	820 (NN)
Mixing/Loading Dry Flowables (water dispersible) for Rights of Way (2c)	roadsides	1	40	6400	**570**	8700	570 g (NN)	32,000	3,300 (NN)
	Bermuda grass hwy rights-of-way	4	40	1600	**140**	2200	140 g (NN)	8000	820 (NN)

Table 9: Summary of Occupational Short-term and Intermediate-term Handler Risks from Atrazine (continued)

Handler Scenario				Baseline MOEs[c]		PPE MOEs[c]		Engineering Control MOEs[e]	
				Short-term	Intermediate-term	Short-term	Intermediate-term	Short-term	Intermediate-term
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre or lb ai/gal)	Area Treated Per Day[b] (Acres)	Aggregate Dermal + Inhalation	Aggregate Dermal + Inhalation	Aggregate: with gloves unless noted and with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted	Aggregate Dermal + Inhalation (NN at all scenarios)	Aggregate Dermal + Inhalation
Loading Granular Formulations (3)	sod farms	2	80	2000	**310**	7400	320 g (NN)	98,000	15,000 (NN)
	golf course turf	2	40	3900	**610**	15000	640 g (NN)	200,000	31,000 (NN)
Applicator									
Applying Liquids with Aircraft (4)	conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL	4	350	See Engineering Controls				2,300	**210**
	sugarcane	2.6	350	See Engineering Controls				3,500	**320**
	chemical fallow	3	1,200	See Engineering Controls				900	82
			350	See Engineering Controls				3,100	**280**
		1.4	1,200	See Engineering Controls				1,900	**170**
			350	See Engineering Controls				6,500	**600**
	CRP or grasslands	2	1,200	See Engineering Controls				1,300	**120**
			350	See Engineering Controls				4,600	**420**
	corn, sorghum	2	1,200	See Engineering Controls				1,300	**120**
			350	See Engineering Controls				4,600	**420**
		1	1,200	See Engineering Controls				2,700	**240**
			350	See Engineering Controls				9,100	**840**
	sod farms	2	350	See Engineering Controls				4,600	**420**
Applying Liquids for Groundboom Application (5)	sugar cane, macadamia nuts, guava, conifers, sod farms in FL	4	80	1700	**210**	3900 (NN)	210 g (NN)	12,000	980 (NN)
	sugarcane	2.6	80	2700	**330**	6000	330 g (NN)	18,000	1,500 (NN)
	chemical fallow	3	450	410	51	920	**99**	2,700	**230**
			200	930	**110**	2100	110 g (NN)	6,200	520 (NN)
		1.4	450	890	**110**	2000	110 g (NN)	5,900	500 (NN)
			200	2000	**240**	4500	240 g (NN)	13,000	1,100 (NN)
	CRP or grasslands	2	450	620	76	1400	**120 g,r**	4,100	350 (NN)
			200	1400	**170**	3100	170 g (NN)	9,300	790 (NN)
	corn, sorghum	2	450	620	76	1400	**120 g,r**	4,100	350 (NN)
			200	1400	**170**	3100	170 g (NN)	9,300	790 (NN)
		1	450	1200	**150**	2800	150 g (NN)	8,200	700 (NN)
			200	2800	**340**	6200	340 g (NN)	19,000	1,600 (NN)
	Bermuda grass hwy rights-of-way	4	40	3500	**430**	7800	430 g (NN)	23,000	2,000 (NN)
	roadsides	1	40	14000	**1,700**	31000	1,700 g (NN)	93,000	7,900 (NN)

Table 9: Summary of Occupational Short-term and Intermediate-term Handler Risks from Atrazine (continued)

Handler Scenario				Baseline MOEs[c]		PPE MOEs[c]		Engineering Control MOEs[e]	
				Short-term	Intermediate-term	Short-term	Intermediate-term	Short-term	Intermediate-term
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre or lb ai/gal)	Area Treated Per Day[b] (Acres)	Aggregate Dermal + Inhalation	Aggregate Dermal + Inhalation	Aggregate: with gloves unless noted and with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted	Aggregate Dermal + Inhalation (NN at all scenarios)	Aggregate Dermal + Inhalation
	golf course turf	2	40	7000	**850**	16000	850 g (NN)	46,000	3,900 (NN)
	sod farms	2	80	3500	**430**	7800	430 g (NN)	23,000	2,000 (NN)
Applying Liquids with a Rights-of-Way Sprayer (6)	Bermuda grass rights-of-way	4	40	110	8.2	370	37	NF	NF
	roadsides	1		430	33	1500	**99 g**	NF (NN)	NF (NN)
Applying Liquids with a Handgun (7)	lawns, golf courses	2	5	NA	see PPE	7200	**500 g**	NF (NN)	NF (NN)
Applying Impregnated Dry Bulk Granular Fertilizer with Tractor Drawn Spreader(8)	corn, sorghum	2	500	420	60	1500 (NN)	**160 g,r**	2,200	320 (NN)
			250	840	**120**	2900	130 g (NN)	4,500	640 (NN)
			143	1500	**210**	5100	230 g (NN)	7,800	1,100 (NN)
		1	500	840	**120**	2900	130 g (NN)	4,500	640 (NN)
			250	1700	**240**	5800	260 g (NN)	9,000	1,300 (NN)
			143	2900	**420**	10000	460 g (NN)	16,000	2,200 (NN)
Applying Granular with a Tractor Drawn Spreader (9)	on farm fertilizer for corn, sorghum	2	200	1000	**150**	3600	170 g (NN)	5,600	790 (NN)
			80	2600	**380**	9100	410 g (NN)	14,000	2,000 (NN)
		1	200	2100	**300**	7300	330 g (NN)	11,000	1,600 (NN)
			80	5200	**750**	18000	830 g (NN)	28,000	4,000 (NN)
	golf course turf	2	40	5200	**750**	18000	830 g (NN)	28,000	4,000 (NN)
Mixer/Loader/Applicator									
Backpack Sprayer: Liquid Formulations (LCO) (10)	lawns, golf courses	2	1	NA	none, see PPE	**4500**	350g,	NF (NN)	NF (NN)
Low Pressure Handwand - Liquid Formulations (LCO) (11)	lawns, golf courses	2	1	**130**	9	18,000	1700 g	NF (NN)	NF (NN)
Lawn Handgun (and Compressed Air Sprayer) (liquid formulations) (LCO) (12)	lawns, golf courses	2	5	NA	none, see PPE	**6600**	**450 g**	12,000 (eng = M/L only)	870 (NN) (eng = M/L only)
Granulars with a Push Type Spreader (LCO) (13)	lawns, golf courses	2	5	4400	60	1900 (NN)	**130 g**	NF (NN)	NF (NN)

Table 9: Summary of Occupational Short-term and Intermediate-term Handler Risks from Atrazine (continued)

Handler Scenario				Baseline MOEs[c]		PPE MOEs[c]		Engineering Control MOEs[e]	
				Short-term	Intermediate-term	Short-term	Intermediate-term	Short-term	Intermediate-term
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre or lb ai/gal)	Area Treated Per Day[b] (Acres)	Aggregate Dermal + Inhalation	Aggregate Dermal + Inhalation	Aggregate: with gloves unless noted and with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted	Aggregate Dermal + Inhalation (NN at all scenarios)	Aggregate Dermal + Inhalation
Granulars with a Bellygrinder (LCO) (14)	lawns, golf courses	2	1	1000	82	1300 (NN)	**95 g,r 130 g,dl**	NF	NF

Table 9: Summary of Occupational Short-term and Intermediate-term Handler Risks from Atrazine (continued)

Handler Scenario				Baseline MOEs[c]		PPE MOEs[c]		Engineering Control MOEs[e]	
				Short-term	Intermediate-term	Short-term	Intermediate-term	Short-term	Intermediate-term
Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre or lb ai/gal)	Area Treated Per Day[b] (Acres)	Aggregate Dermal + Inhalation	Aggregate Dermal + Inhalation	Aggregate: with gloves unless noted and with dust/mist respirator	Aggregate with gloves + double layers + respirator, unless noted	Aggregate Dermal + Inhalation (NN at all scenarios)	Aggregate Dermal + Inhalation
Flagging									
Flagging Sprays (15)	conifer forest, sugarcane, conifer (Christmas tree) farms, sod farms	4	350	700	76	1400 dl (NN)	81 dl	2,600	**220**
	sugarcane	2.6	350	1100	**120**	2100 dl (NN)	120 dl (NN)	4,000	350 (NN)
	chemical fallow	3	350	930	**100**	1900 dl (NN)	110 dl	3,500	300 (NN)
		1.4	350	2000	**220**	4000 dl (NN)	230 dl (NN)	7,500	640 (NN)
	CRP or grasslands	2	1,200	410	45	810 dl (NN)	67 dl,r	1,500	**130**
			350	1400	**150**	2800 dl (NN)	160 dl (NN)	5,300	450 (NN)
	corn, sorghum	2	1,200	410	45	810 dl (NN)	67 dl,r	1,500	**130**
			350	1400	**150**	2800 dl (NN)	160 dl (NN)	5,300	450 (NN)
		1	1,200	820	89	1600 dl (NN)	95 dl	3,100	**260**
			350	2800	**310**	5600 dl (NN)	320 dl (NN)	11,000	900 (NN)
	sod farms	2	350	1400	**150**	2800 dl (NN)	160 dl (NN)	5,300	450 (NN)

Footnotes:

a Application rates represent maximum rates determined from EPA registered labels for atrazine. Typical use rates as determined by BEAD were assessed for corn and sorghum (1.0 lb ai/acre), sugarcane (2.6 lb ai/acre) and chemical fallow (1.4 lb ai/acre).
b Area Treated (acres treated per day) based on Exposure SAC Policy # 9 "Standard Values for Daily Acres Treated In Agriculture," Revised June 23, 2000.
c Baseline MOEs: see Occupational Short-term and Intermediate-term Handler Risks from Atrazine at Baseline Table.
d PPE MOEs: see Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Risk Mitigation Table.
e Engineering Control MOEs: see Occupational Short-term and Intermediate-term Handler Risks from Atrazine with Engineering Controls Table.

UNK = Unknown -- additional use information needed
NN = Not needed -- MOE > 100 at previous risk mitigation level
NF = Not feasible -- no engineering control known for this application method
Bold = uncertainty factor (MOE) reached or exceeded at that risk mitigation level
Shaded = uncertainty factor (MOE) not attained at maximum feasible risk mitigation
dl = double layer clothing (coveralls over single layer)
g = gloves
r = respirator

Table 10: Occupational Handler Short-Term and Intermediate-Term Risks for LCO's Applying Atrazine (assessed using ORETF unit exposure values)

Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre)	Acres Treated Per Day[b]	Baseline Unit Exposure Values		Baseline Short-Term Risks				Baseline Intermediate-Term Risks				
						Daily Dose (mg/kg/day)		MOEs		Daily Dose[e] (mg/kg/day)		MOEs		
				Dermal[c] (mg/lb ai)	Inhalation[d] (µg/lb ai)	Dermal[e]	Inhalation[f]	Dermal[g]	Inhalation[h]	Dermal[e]	Inhalation[f]	Dermal[g]	Inhalation[h]	Aggregate[i]
Mixer/Loader/Applicator														
Lawn Handgun (and Compressed Air Sprayer) (liquid formulations) (12a)	lawns, golf courses	2	5	0.69	1.5	0.099	0.00025	3,700	40,000	0.0069	0.00025	260	7,200	250
Lawn Handgun (and Compressed Air Sprayer) - (water dispersible granules) (12b)				0.92	22	0.13	0.0037	2,700	2,700	0.0092	0.0037	200	490	140
Lawn Handgun (and Compressed Air Sprayer) - (water soluble bag packaging) (12c)				0.96	7.7	0.14	0.0013	2,600	7,800	0.0096	0.0013	190	1,400	170
Granulars with a Push Type Spreader (13)				0.31	14	0.044	0.0023	8,100	4,300	0.0031	0.0023	580	770	330

Footnotes:

a Application rates represent maximum rates determined from EPA registered labels for atrazine.
b Acres treated per day values are EPA estimates found in Exposure SAC Policy # 9 "*Standard Values for Daily Acres Treated in Agriculture*", revised June 23, 2000.
c Dermal unit exposure values (geometric mean values) from 2 Outdoor Residential Exposure Task Force studies (ORETF Study Number OMA001 and OMA002). Unit exposure data were analyzed in 2 EPA draft memos, dated October 19, 2000 " *Exposure of Professional Lawn Care Workers During the Mixing, Loading, and Application of Granular Turf Pesticides Utilizing a Surrogate Compound* and "Exposure of Professional Lawn Care Workers During the Mixing and Loading of Dry and Liquid Application of Turf Pesticides Utilizing a Surrogate Compound. LCO exposure was assessed in this table assuming a long pants, long sleeved shirt , no gloves clothing scenario.
d Inhalation unit exposure values from the same ORETF studies cited in footnote c and assuming a no respirator scenario.
e Dermal daily dose (mg/kg/day) = daily unit exposure (mg/lb ai) x application rate (lb ai/acre) x area treated per day (acres/day) / body weight (70 kg adult for short-term and 60 kg developmental female for intermediate-term). A 6% dermal absorption factor applies for intermediate-term dermal dose.
f Inhalation daily dose (mg/kg/day) = inhalation unit exposure (µg/lb ai) x application rate (lb ai/acre) x area treated per day (acres/day) x conversion factor (1 mg/1,000 µg) / body weight (60 kg female for both short- and intermediate-term).
g Dermal MOE = NOAEL (360 mg/kg/day for short-term and 1.8 mg/kg/day for intermediate-term) / daily dermal dose (mg/kg/day).
h Inhalation MOE = NOAEL (10 mg/kg/day for short-term and 1.8 mg/kg/day for intermediate-term) / daily inhalation dose (mg/kg/day).
i Aggregate MOE for intermediate-term assessments = NOAEL (1.8 mg/kg/day) / absorbed daily dermal + inhalation dose (mg/kg/day)

Table 11. Turf Transferable (TTR) and Dislodgeable Foliar Residue (DFR) Values from Registrant Submitted Studies (used in Postapplication Assessment)

MRID 449580-01 Atrazine Liquid Turf Application Study Rate: 2 lb ai/acre			**MRID 449588-01** Atrazine Granular Turf Application Study Rate: 2 lb ai/acre			**MRID 448836-01** Atrazine Liquid Application to Corn Study Rate: 2.0 lb ai/acre - 4L Formulation 2.5 lb ai/acre - Dry Flowable Formulation			
DAT (days)	GA TTR (µg/cm^2)	NC TTR (µg/cm^2)	DAT (days)	GA TTR (µg/cm^2)	FL TTR (µg/cm^2)	DAT (days)	MO DFR (µg/cm^2) 4L Formulation	MO DFR (µg/cm^2) Dry Flowable Formulation	MO DFR (µg/cm^2) Dry Flowable Formulation (Normalized to represent 2 lb ai/a application)
0	0.182	0.219	0	**0.0585**	0.162	0			
0.5	**0.241**	**1.32**	0.167	--	**0.216**	0.167	2.64	4.21	**3.37**
1	0.117	0.116	0.79	0.0145	--	0.5	1.61	2.7	2.16
3	0.2	0.135	1	0.0351	0.0883	1	1.54	2.04	1.63
5	0.117	0.139	3	0.0182	0.0536	2	1.35	1.92	1.54
7	**0.0658**	**0.0523**	7	**0.0105**	**0.0393**	3	0.453	0.973	0.78
14	0.0299	0.0375	10	0.00608	0.0269	5	0.362	0.0684	0.05
21	0.14	0.00307	14	0.006	0.0166	7	0.0937	0.128	**0.10**
			21	0.00308	0.00242				
			28	--	0.00206				
			30	0.00124	--				
			35	0.00108	0.00163				

NOTE: Bolded numbers were used in the postapplication assessments for DAT 0-1 and DAT 7 residue values.

Table 12. Occupational Short- and Intermediate-Term Postapplication Risks for Atrazine
(Using DFR values from Atrazine corn study MRID No. 448836-01)

Crop/Use Pattern	Application Rate (lb ai/acre)	Postapplication Activity	Transfer Coefficient[a]	Short Term Risks		Intermediate Term Risks	
				DFR[b] (µg/cm^2) (DAT 0-1)	MOE[c]	DFR[d] (ug/cm^2) (DAT 7)	MOE[e]
Corn	2	Scout (minimum foliage)	400	3.37	2,300	0.102	5,500
		Irrigate, weed (minimum foliage)	100	3.37	9,400	0.102	22,000
Conifer Forests	4	Scout	1,000	6.74	470	0.205	1,100
Christmas Tree Farms	4	Stake, top, train, harvest (full foliage)	8,000	6.74 (DAT 0-1)	58 (DAT 0-1)	0.205	140
				3.260 (DAT 1)	120 (DAT 1)		
		Prune	3,000	6.74	160	0.205	370
		Scout, thin	1,000	6.74	470	0.205	1,100
Sugarcane	4	Scout (full foliage)	2,000	6.74	230	0.205	550
Sorghum	2	Scout, irrigate (minimum foliage)	100	3.37	9,400	0.102	22,000

a Transfer coefficient from Science Advisory Council for Exposure: Policy Memo # 003 .1 "Agricultural Transfer Coefficients," Revised - August 7, 2000.

b DFR source: corn study MRID # 448836-01, DAT 0-1 residue unless an MOE of >100 was not reached. In such cases risks were assessed on days following application until an MOE of 100 was determined. The highest residue value occurring between DAT 0-1 was used for determination of DAT 1 MOE's. The highest residue values were detected after application of a 90 DF wettable powder formulation. The study was conducted using an application rate of 2.5 lb ai/acre. The residues were first normalized to reflect an application rate of 2.0 lb ai/acre to aid in determination of highest residues (i.e., the 90 DF vs 4L formulations). When assessing activities involving a different application rate than was used in the study, the DFR values were adjusted proportionately to reflect the different application rates. For example, for sugarcane, which has a maximum label rate of 4.0 lb ai/acre, adjusted DFR =

$$\frac{\text{Corn DFR} \times \text{4 lb ai/A for sugarcane}}{\text{2 lb ai/A for corn}}$$

c MOE = Short-term NOAEL (360 mg/kg/day; based on a dermal study) / dermal dose where dose = DFR (µg/cm^2) x TC (cm^2/hr) x conversion factor (1 mg/1,000 µg) x exposure time (8 hrs/day) / body weight (70 kg adult).

d DFR source: corn study MRID # 448836-01, DAT 7 residue. See footnote b for further explanation.

e MOE = Intermediate-term NOAEL (1.8 mg/kg/day; based on an oral developmental study) / absorbed dermal dose where absorbed dose = DFR (µg/cm^2) x TC (cm^2/hr) x conversion factor (1 mg/1,000 µg) x exposure time (8 hrs/day) x dermal absorption (6%) / body weight (60 kg developmental female).

Note: DFR = Dislodgeable Foliar Residue

Table 13: Occupational Short- and Intermediate-Term Postapplication Risks for Granular Atrazine Formulations
(Using TTR values from granular Atrazine turf study MRID No. 449588-01)

Crop/Use Pattern	Application Rate (lb ai/acre)	Postapplication Activity	Transfer Coefficient	Short Term Risks				Intermediate Term Risks			
				TTR[b] (ug/cm²) (DAT 0-1)		MOE[c]		TTR[d] (ug/cm²) (DAT 7)		MOE[e]	
				GA	FL	GA	FL	GA	FL	GA	FL
Golf Course Turf	2	Mow, seed, scout, mechanical weed, aerate, fertilize, prune	500	0.0585	0.216	110,000	29,000	0.0105	0.0393	43,000	11,000
		Transplant, high contact	16,500	0.0585	0.216	3,300	880	0.0105	0.0393	1,300	350
Sod Farms (FL)	4	Mow, scout, mechanical weed, irrigate	500	NA				0.021	0.0786	21,000	5,700
		Transplant, hand weed, harvest (hand or mechanical)	16,500	NA				0.021	0.0786	650	170
Sod Farms	2	Mow, scout, mechanical weed, irrigate	500	NA				0.0105	0.0393	43,000	11,000
		Transplant, hand weed, harvest (hand or mechanical)	16,500	NA				0.0105	0.0393	1,300	350
Macadamia Nuts/Guava	4	Mow, scout, irrigate (turf under the trees)	500	0.117	0.432	54,000	15,000	0.021	0.0786	21,000	5,700

a Transfer coefficient from Science Advisory Council for Exposure: Policy Memo # 003 .1 "Agricultural Transfer Coefficients," Revised - August 7, 2000.

b TTR source: granular atrazine to turf study MRID # 449588-01, DAT 0-1 residue. The highest residue value occurring between DAT 0-1 was used for determination of DAT 1 MOE's. The study was conducted in GA and FL using an application rate of 2.0 lb ai/acre. When assessing activities involving a different application rate than was used in the study, the TTR values were adjusted proportionately to reflect the different application rates. For example, for Bermuda grass rights of way, which have a maximum label rate of 4.0 lb ai/acre, adjusted TTR = $\frac{\text{Turf TTR x 4 lb ai/A for Bermuda grass rights of way}}{\text{2 lb ai/A for turf}}$

c MOE = Short-term NOAEL (360 mg/kg/day; based on a dermal study) / dermal dose where absorbed dose = TTR (µg/cm²) x TC (cm²/hr) x conversion factor (1 mg/1,000 µg) x exposure time (8hrs/day)/ body weight (70 kg; adult).

d TTR source: granular atrazine turf study MRID # 449580-01, DAT 7 residue. See footnote b for further explanation.

e MOE = Intermediate-term NOAEL (1.8 mg/kg/day; based on an oral developmental study) / absorbed dermal dose where absorbed dose = TTR (µg/cm²) x TC (cm²/hr) x conversion factor (1 mg/1,000 µg) x exposure time (8 hrs/day) x dermal absorption (6 %) / body weight (60 kg; developmental female).

NA = Not applicable to this scenario.

TTR - Turf Transferable Residue

Table 14. Occupational Short- and Intermediate-Term Postapplication Risks for Liquid Atrazine Formulations
(Using TTR values from liquid Atrazine turf study MRID No. 449580-01)

Crop/Use Pattern	Application Rate (lb ai/acre)	Postapplication Activity	Transfer Coefficient[a] (TC)	Short Term Risks				Intermediate Term Risks			
				TTR[b] (ug/cm²) (DAT 0-1)		MOE[c]		TTR[d] (ug/cm²) (DAT 7)		MOE[e]	
				GA	NC	GA	NC	GA	NC	GA	NC
Golf Course Turf	2	Mow, seed, scout, mechanical weed, aerate, fertilize	500	0.241	1.32	26,000	4,800	0.0658	0.052	6,800	8,600
		Transplant, high contact	16,500	0.241	1.32	790	140	0.0658	0.052	210	260
Sod Farms (FL)	4	Mow, scout, mechanical weed, irrigate	500	NA				0.1316	0.1046	3,400	4,300
		Transplant, hand weed, harvest (hand or mechanical)	16,500	NA				0.1316	0.1046	100	130
Sod Farms	2	Mow, scout, mechanical weed, irrigate	500	NA				0.0658	0.052	6,800	8,600
		Transplant, harvest (hand or mechanical)	16,500	NA				0.0658	0.052	210	260
Macadamia Nuts/Guava	4	Mow, scout, irrigate (turf under the trees)	500	0.482	2.64	13,000	2,400	0.1316	0.1046	3,400	4,300

a Transfer coefficient from Science Advisory Council for Exposure: Policy Memo # 003 .1 "Agricultural Transfer Coefficients," Revised - August 7, 2000.

b TTR source: liquid atrazine to turf study MRID # 449580-01, DAT 0-1 residue unless an MOE of >100 was not reached. In such cases risks were assessed on days following application until an MOE of 100 was determined. The highest residue value occurring between DAT 0-1 was used for determination of DAT 1 MOE's. The study was conducted in GA and NC using an application rate of 2.0 lb ai/acre. When assessing activities involving a different application rate than was used in the study, the TTR values were adjusted proportionately to reflect the different application rates. For example, for Bermuda grass rights of way, which have a maximum label rate of 4.0 lb ai/acre, adjusted TTR = $\frac{\text{Turf TTR x 4 lb ai/A for Bermuda grass rights of way}}{\text{2 lb ai/A for turf}}$

c MOE = Short-term NOAEL (360 mg/kg/day; based on a dermal study) / dermal dose where dose = TTR (µg/cm²) x TC (cm²/hr) x conversion factor (1 mg/1,000 µg) x exposure time (8 hrs/day) / body weight (70 kg adult).

d TTR source: liquid atrazine turf study MRID # 449580-01, DAT 7 residue. See footnote b for further explanation.

e MOE = Intermediate-term NOAEL (1.8 mg/kg/day; based on an oral developmental study) / absorbed dermal dose where absorbed dose = TTR (µg/cm²) x TC (cm²/hr) x conversion factor (1 mg/1,000 µg) x exposure time (8 hrs/day) x dermal absorption (6%) / body weight (60 kg female).

NA = Not applicable to this scenario.

TTR = Turf Transferable Residue

Table 15: Residential Exposure Scenario Descriptions for the Use of Atrazine

Exposure Scenario (Number)	Data Source	Standard Assumptions[a]	Comments[b]
Mixer/Loader/Applicator Descriptors			
Backpack Sprayer (R1)	SOPs for Residential Exposure Assessments (12/97)	0.023 acres (1000 ft^2) for spot treatment	**Baseline:** Dermal (9-11 replicates) exposure value is based on AB grade data, hand (11 replicates) exposure value is based on C grade data, and inhalation (11 replicates) exposure value is based on A grade data. Low confidence in hands/dermal and inhalation data. A 90% protection factor was used to "back calculate" the "no glove" hand scenario from gloved hand data.
Low Pressure Handwand - Liquid Formulations (R2)	SOPs for Residential Exposure Assessments (12/97)	0.023 acres (1000 ft^2) for spot treatment	**Baseline**: Dermal (9-80 replicates) and inhalation (80 replicates) exposure values are based on ABC grade data, and hand (70 replicates) exposure value is based on All grade data. Low confidence in hand/dermal data. Medium confidence in inhalation data.
Hose-End Sprayer (R3)	SOPs for Residential Exposure Assessments (12/97)	0.5 acres	**Baseline**: Dermal (8 replicates) and inhalation (8 replicates) exposure values are based on C grade data, and hand (8 replicates) exposure value is based on E grade data. Low confidence in all data. A 50 percent protection factor was applied to the dermal figure to simulate short pants and short-sleeved shirt.
	ORETF Study - OMA004	Same as above	**Baseline:** Dermal, hand and inhalation (30 replicates each for long sleeved, long pants scenario) data used to establish exposure values. High confidence. May use instead of low-confidence PHED v.1.1 data.
Push-type Granular Spreader (R4)	SOPs for Residential Exposure Assessments (12/97)	0.5 acres	**Baseline:** Hand (15 replicates) and dermal (0-15 replicates) exposure values are based on C grade data. Inhalation (15 replicates) exposure values based on B grade data. Low confidence in hand/dermal data, and high confidence in inhalation data.. A 50% protection factor was used to "back-calculate" a short sleeved shirt value from long sleeve shirt data.
	ORETF Study - OMA003	Same as above	**Baseline:** Hand, dermal, and inhalation (30 replicates each) data used to establish exposure values. High confidence. Compare to PHED data; consider pooling data.

Table 15: Residential Exposure Scenario Descriptions for the Use of Atrazine (continued)

Exposure Scenario (Number)	Data Source	Standard Assumptions[a]	Comments[b]
Granulars with a Bellygrinder (R5)	SOPs for Residential Exposure Assessments (12/97)	0.023 acres (1,000 ft^2) for spot treatment	**Baseline:** Dermal (20-45 replicates) and Hand (23 replicates) exposure values are based on ABC grade data. Inhalation (40 replicates) exposure value is based on AB grade data. Medium confidence in dermal/hand data and high confidence in inhalation data.

[a] Standard Assumptions based on Residential SOPs and HED estimates.

[b] "Best Available" grades are defined by HED SOP for meeting Subdivision U Guidelines. Best available grades are assigned as follows: matrices with grades A and B data and a minimum of 15 replicates; if not available, then grades A, B and C data and a minimum of 15 replicates; if not available, then all data regardless of the quality and number of replicates. Data confidence are assigned as follows:

High = grades A and B and 15 or more replicates per body part
Medium = grades A, B, and C and 15 or more replicates per body part
Low = grades A, B, C, D and E or any combination of grades with less than 15 replicates

Table 16a. Residential Short-term Handler Risks to Atrazine at Baseline

Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre)	Amount Handled per Day[b] (acres)	PHED Unit Exposure		Daily Dose		MOEs		
				Dermal[c] (mg/lb ai)	Inhalation[d] (µg/lb ai)	Dermal[e] (mg/kg/day)	Inhalation[f] (mg/kg/day)	Dermal[g]	Inhal-ation[h]	Aggregate
Mixer/Loader/Applicator										
Backpack Sprayer (R1)	lawns	2	0.023	5.1	30	0.0034	0.000023	150,000	430,000	110,000
Low Pressure Handwand - Liquid Formulations (R2)	lawns	2	0.023	100	30	0.066	0.000023	7,600	430,000	7,500
Granulars with a Push Type Spreader (R4)	lawns	2	0.5	3	6.3	0.043	0.00011	8,400	95,000	7,700
Granulars with a Bellygrinder (R5)	lawns	2	0.023	110	62	0.072	0.00005	5,000	210,000	4,900

Footnotes:

a Application rates are the maximum application rates determined from EPA registered labels.

b Amount handled per day values are EPA estimates of acreage treated, as found in the Residential SOPs draft December 1997; 0.5 acre lawn or 1000 ft^2 (0.023) acre spot treatment..

c Dermal unit exposure values from Residential SOPs draft December 1997. Baseline dermal exposure assumes short pants, short sleeved shirt, and no gloves. All scenarios are considered mixer/loader/applicators.

d Inhalation unit exposure values from the Residential SOPs draft December 1997 representing a no respirator scenario.

e Dermal daily dose (mg/kg/day) = daily unit exposure (mg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) / body weight (70 kg adult).

f Inhalation daily dose (mg/kg/day) = inhalation unit exposure (µg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) x conversion factor (1 mg/1,000 µg) / body weight (60 kg; developmental female).

g Dermal MOE = NOAEL (360 mg/kg/day based) / daily dermal dose (mg/kg/day)..

h Inhalation MOE = NOAEL (10 mg/kg/day) / daily inhalation dose (mg/kg/day).

Table 16b. Residential Short-term Handler Risks to Atrazine at Baseline (Using ORETF Unit Exposure Values)

Exposure Scenario	Crop Type/Use	Application Rate[a] (lb ai/acre)	Amount Handled per Day[b] (acres)	ORETF Unit Exposure		Daily Dose		MOEs		
				Dermal[c] (mg/lb ai)	Inhalation[d] (µg/lb ai)	Dermal[e] (mg/kg/day)	Inhalation[f] (mg/kg/day)	Dermal[g]	Inhal-ation[h]	Aggregate
Mixer/Loader/Applicator										
Hose-end (Dial-Type) Sprayer (R3)	lawns	2	0.5	11	16	0.16	0.00027	2,300	38,000	2,200
Granulars with a Push Type Spreader (R5)	lawns	2	0.5	0.68	0.91	0.0097	0.00002	37,000	660,000	35,000

Footnotes:

a Application rates are the maximum application rates determined from EPA registered labels.

b Amount handled per day values are EPA estimates of acreage treated found in the Residential SOPs draft December 1997. Baseline dermal exposure assumes short pants, short sleeved shirt, and no gloves clothing scenario. All scenarios are considered mixer/loader/applicators.

c Dermal unit exposure values from 2 Outdoor Residential Exposure Task Force ORETF (MRID 449722-01 and ORETF Study Number OMA003) studies. Unit exposure data (geometric mean values) were analyzed in 2 EPA draft memos, one dated October 19, 2000 "*A Generic Evaluation of Homeowner Exposure Associated with Liquid Pesticide Handling and Hose-End Application to Residential Lawns"* vol 6 of 6. The other data evaluation memo was also dated October 19, 2000 "*A Generic Evaluation of Homeowner Exposure Associated with Granular Turf Pesticide Handling and Application to Residential Lawns*". Homeowner exposure was assessed in this table using a short sleeved shirt, short pants, no glove clothing scenario.

d Inhalation unit exposure values from the same ORETF studies cited in footnote c representing "no respirator" scenarios.

e Dermal daily dose (mg/kg/day) = daily unit exposure (mg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) / body weight (70 kg adult).

f Inhalation daily dose (mg/kg/day) = inhalation unit exposure (µg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) x conversion factor (1 mg/1,000 µg) / body weight (60 kg developmental female).

g Dermal MOE = NOAEL (360 mg/kg/day) / daily dermal dose (mg/kg/day).

h Inhalation MOE = NOAEL (10 mg/kg/day) / daily inhalation dose (mg/kg/day).

Table 17. Residential Short-term Dermal Postapplication Risks for Atrazine

(Using TTR values from liquid and granular Atrazine turf studies - MRID Nos. 449580-01, 449588-01)

Dermal Scenarios	Application Rate (lb ai/acre)	Exposure Time (hours/day)	Short Term Risks				
			Transfer Coefficient[a] (cm^2/hr)	TTR[b] (ug/cm^2) DAT 0-1		MOEs [c]	
				GA	NC-liquid FL-granular	GA	NC-liquid FL- granular
Adult dermal turf contact liquid formulation	2	2	14,500	0.241	(NC) 1.32	3,600	(NC) 660
Adult dermal turf contact granular formulation	2	2	14,500	0.0585	(FL) 0.216	15,000	(FL) 4,000
Child dermal turf contact liquid formulation	2	2	5,200	0.241	(NC) 1.32	2,200	(NC) 390
Child dermal turf contact granular formulation	2	2	5,200	0.0585	(FL) 0.216	8,900	(FL) 2,400
Adult walking, playing golf liquid formulation	2	4	500	0.241	(NC) 1.32	52,000	(NC) 9,500
Adult walking, playing golf granular formulation	2	4	500	0.0585	(FL) 0.216	220,000	(FL) 58,000
Adult push mowing lawn liquid formulation	2	2	500	0.241	(NC) 1.32	100,000	(NC) 19,000
Adult push mowing lawn granular formulation	2	2	500	0.0585	(FL) 0.216	460,000	(FL) 120,000
Aggregate Daily Dermal Risk: Adult (All Activities Listed): Liquid Formulation[f]						3,300	600
Aggregate Daily Dermal Risk: Adult (All Activities Listed): Granular Formulation[f]						14,000	3,600

a Transfer coefficient from proposed changes to the Residential SOP's (12/99).

b TTR source: liquid and granular turf studies MRID # 449580-01, 449588-01, DAT 0-1 residue. The highest residue value occurring immediately following application to DAT 1 was used for determination of DAT 0-1 MOE's. The highest residue values were detected after liquid application of a 90 DF formulation. The 90 DF study was conducted using an application rate of 2 lb ai/acre.

c MOE = Short-term NOAEL (360 mg/kg/day; based on a dermal study) / dermal dose where dermal dose = TTR (µg/cm^2) x TC (cm^2/hr) x conversion factor (1 mg/1,000 µg) x exposure time (2 hrs/day) / body weight (70 kg adult or 15 kg 1- to 6-year-old).

d TTR source: liquid and granular turf studies MRIDs # 449580-01, 449588-01, DAT 7 residue.

e MOE = Intermediate-term NOAEL (1.8 mg/kg/day; based on an oral study) / absorbed dermal dose where absorbed dose = TTR (µg/cm^2) x TC (cm^2/hr) x conversion factor (1 mg/1,000 µg) x exposure time (2 hrs/day) x dermal absorption (6%) / body weight (60 kg developmental female or 15 kg child (1-6 year old)).

f Aggregate MOE may be obtained by dividing NOAEL by sum of daily dermal doses, or by taking the inverse of the sum of the inverses of the MOEs:

$$\text{Aggregate MOE} = 1/[\ 1/MOE_1 + 1/MOE_2 \text{ etc.}]$$

Note: TTR = Turf Transferable Residue

Table 18. **Residential Short-term Oral Nondietary Postapplication Risks to Children (1-6) from "Hand-to-Mouth" and Ingestion Exposure When Reentering Lawns Treated with Granular or Liquid Atrazine Formulations**

Type of Exposure	Application Rate[a] (lb ai/acre)	Ingestion Rate or Other Assumptions[b]	Oral Dose[d] (mg/kg/day)	MOE[e]
Hand to Mouth Activity ("finger licking")	2 liquid or granular	20 cm^2/event surface area of 1-3 fingers; 20 events/hr; 5% of ai dislodgeable with potentially wet hands; 50% saliva extraction factor	0.030 (both formulations)	330
Turfgrass/Object Mouthing	2 liquid or granular	25 cm^2/day of turf; Corn DFR normalized to 2 lb ai/acre = 3.4 µg/cm^2	0.0057	1,800
Ingestion of Soil	2 liquid or granular	100 mg/day ingestion; 0.67 cm^3/gm soil	1.0E-4	100,000
Aggregate of the Oral Exposures Above[f]			0.036	280
Ingestion of Granules	0.42% ai	0.2-0.4 g/day (100-200 lbs formulation /acre)	0.056-0.11	90-180
	1.5% ai		0.2-0.4	25-50

Footnotes:

a Application rates represent maximum label rates from current EPA registered labels.

b Assumptions from Residential SOP's (December, 1999). Several assumptions used in calculating the hand to mouth activity scenario involve proposed changes to the Residential SOPs (12/99).

c TTR source: liquid and granular atrazine turf studies MRID Nos. 449580-01; 449588-01. Short-term risks assessed using DAT 0-1 residue values and intermediate-term risks assessed using DAT 7 residue values.

d Oral doses calculated using formulas presented in the Residential SOPs (December, 1999). Short-term and intermediate-term doses were calculated using the following formulas. Intermediate term doses were each multiplied by the estimated fraction of atrazine residue remaining on DAT 7 after application. An estimated 17 % of the initial DAT 0-1 residue remained after 7 days, based on the mean of the average values from 4 test sites reported in the studies (i.e., 2 test sites for the liquid formulation and 2 for the granular formulation. MRIDs 449580-01; 449588-01)

Hand-to-mouth; oral dose to child (1-6 year old) on the day of treatment (mg/kg/day**)** = [application rate (lb ai/acre) x fraction of residue dislodgeable with potentially wet hands (5%) x 11.2 (conversion factor to convert lb ai/acre to µg/cm^2)] x median surface area for 1-3 fingers (20 cm^2/event) x hand-to-mouth rate (ST: 20 events/hour; IT: 9.5 events/hour) x 50% saliva extraction factor x exp. time (2 hr/day) x 0.001 mg/µg] / bw (15 kg child). This formula is based on proposed changes to the December 1999 Residential SOPs.

Grass/object mouthing; oral dose to child (1-6 year old) on the day of treatment (mg/kg/day) = DFR from corn DF study normalized to 2 lb ai/acre = 3.4 µg/cm^2) x ingestion rate of grass (25 cm^2/day) x .001 mg/µg] / bw (15 kg child).

Soil ingestion; oral dose to child (1-6 year old) on the day of treatment (mg/kg/day) = [(application rate (lb ai/acre) x fraction of residue retained on uppermost 1 cm of soil (100% or 1.0/cm) x 4.54E+08 µg/lb conversion factor x 2.47E-08 acre/cm^2 conversion factor x 0.67 cm^3/g soil conversion factor) x 100 mg/day ingestion rate x 1.0E-06 g/µg conversion factor] / bw (15 kg). Short term dose based residue on the soil on day of application.

Granular pellet ingestion: (mg/kg/day) oral dose to child (1-6 year old) = [Granule ingestion rate (0.2-0.4 g/day) x Fraction of ai of granule formulations x 1,000 mg/g] / bw (15 kg).

Intermediate-term doses were calculated using these formula

e Oral MOE = Oral NOAEL (10 mg/kg/day for both short- and intermediate-term assessments) / Oral Dose (mg/kg/day). Oral NOAEL determined from a rat study. MOEs are reported to two significant figures; target MOE is at least 1,000.

f Aggregate MOE may be obtained by dividing oral NOAEL by sum of oral doses, or by taking the inverse of the sum of the inverses of the MOEs:

Aggregate MOE = $1/[\ 1/MOE_1 + 1/MOE_2$ etc.]